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The Kemmler Case. As we go to press the announcement is made that the United States Supreme Court has refused Mr. Sherman's application for a writ of habeas corpus. Judge Wallace will therefore vacate the writ granted by him; but a writ of error will be heard in Washington on May 19. In the arguments then presented the same ground may be gone over that has been rehearsed so often in this State, but beyond delaying Kemmler's execution, they seem to us likely to be ineffective, in view of the court's refusal to sustain Judge Wallace.

The Physiological Effects of Electric Currents. IN view of the work of recent English experimenters, the paper from Dr. Tatum will be read with interest. He shows, by a series of experiments upon dogs, that while the alternating current is distinctly more dea ily than the continuous, its fatal superiority is far less than some recent experiments would lead us to think. The currents that were endured without fatal result are larger than one might suppose, and the whole tendency of the experiments is to show the sensational character of some of the reports that have been circulated so freely. Accidents and electricians' guesses do not give very satisfactory information, and exact researches from the medical viewpoint cannot fail to be of interest and value.

Duplex Telephony. FROM Dr. Rosebrugh's communication in this issue of the WORLD it would seem that duplex telephony was destined to take an important place in practical usage at an early date. The results attained thus far are certainly very encouraging. With four trunk lines between Toronto and Parkdale four switching circuits are available, three of which are free from induction, although the electric light induction is unusually strong on other circuits on the same route. From the reasons pointed out, Dr. Rosebrugh seems to be justified in believing that duplex telephony is likely to play an important rôle in the solution of the long-distance telephony problem.

The Daft Consolidation. IT was a subject of rumor last week that the Daft Electric Company and the Julien Electric Company had united to form a gigantic corporation for the development of electric traction. We refrained from commenting on this at the time, because some circumstances cast doubt on the connection of the Julien Company with the combination; and we thereby avoided falling into an error, for we have official information from the Julien Company that they are not parties to the deal in question, and that such a combination has not bee n made and will not be made. The Julien Company is making important additions to its facilities in various directions, and is being put on a strengthened basis that bespeaks much fut ure use and activity. This fact, coupled with the union of all the Daft companies into one central company under the name of the United Electrical Traction Company, has probably been the cause of the rumor that was current last week. It is certain that electric traction by storage batteries is going to be developed, and it is not impossible that both the Julien and the Daft companies may have a hand in it, but they have not officially or unofficially combined.

Telegraphing Under Difficulties. AN interesting paper comes from England, dealing with some difficult problems in telegraph engineering. In India, cables across rivers are subject to such rapid deterioration that extraordinary means of transmission must be tried, and some of the expedients used are exceedingly interesting. For short distances it proved possible to signal across an intervening river without a wire by the device of grounding the line by means of large plates sunk in the two banks. Signals were clearly transmitted by the use of a relay; though by reason of the difficulty of balancing earth currents, the method did not prove thoroughly available. By use of special signalling apparatus, however, it was quite practicable to use uninsulated telegraph wire under water, thus doing away with the necessity of a cable. A very interesting point was brought out in the discussion of the paper when Mr. Mordey stated on the authority of Mr. Preece that the dynamos in the great alternating central station at Deptford disturbed the telephones in Paris. In view of the telephone interference suits in this country, such a statement suggests horrible possibilities in the way of international complications produced by the vagaries of unruly earth currents.

Lighting Trains by Storage Batteries. THE account of the lighting of a railroad train given on our next page should be of special interest to such of our readers who have had the good fortune to travel by the Pennsylvania Limited, which is the train selected for illustration. The use of electricity for train lighting is gradually becoming more and more general, and has now been so far systematized as to involve no extraordinary trouble or expenditure. The principal difficulty which has to be met is the kind of an engine for driving the dynamo on the train. That difficulty may be happily solved by the appearance of a very high-speed engine; or experience may show that it is better to rely entirely upon the storage battery. The process of handling the batteries shown in one of our cuts is, however, not an easy one, owing to the great weight which has to be transferred, so that for the present the combination of dynamo and battery will probably continue to be used. The dynamo room of the Pennsylvania station is excellently fitted up both for charging storage batteries and for the regular lighting work, and a glance at it shows how important electricity has come to be in the service of railroads.

The Storage Battery in Paris. IT seems probable that there is to be a boom in storage battery traction in American cities, and therefore M. Gadot's discussion, of which the first portion is published this week, seems peculiarly timely. Considering the dismal view of the case displayed in Brussels, it is decidedly encouraging to have evidence from Paris distinctly favorable to the accumulator cars. M. Gadot goes into the question of economy in detail, and apparently without the bias of enthusiasm. His estimate of efficiency from steam engine to the car wheels is very conservative—in fact, somewhat too low—and he is disposed to face every difficulty squarely. It is quite certain that storage battery cars can be a valuable addition to our present means of rapid transit, provided they can be proved to be reasonably economical. It is therefore pleasant to find the author of the present research holding that they can advantageously replace horses in as large a tramway system as that of Paris. It would be strange if France should develop so important an electrical field in advance of America, and it is to be hoped that we shall soon see increased activity here. Many inventors are working on the problems involved, and their efforts should not long remain unavailing.

Electricity in Spokane. WE give in the present issue some account of the electrical development of Spokane Falls, Washington. It is greatly to the credit of our northwestern brethren that they have been so quick to see the utility of electricity as a motive power, and, on appreciating the fact, have been so prompt in action. Such towns have one great advantage. They can start completely untrammelled to develop a lighting and power system, unharassed by the presence of gas companies or horse railroads, and the result is that the electric light and electric power can make more rapid progress in a new western town than almost anywhere else. The electric railway system in Spokane seems to have been a very decided success, and it will be particularly interesting to our readers, inasmuch as the motive power used is water. There are scattered through the country various electric roads and lighting plants operated by water power, but it is rare to meet with a report of such uniform success as comes from the little city in Washington. Where water power can be secured, without paying a heavy rental, it is so much cheaper than steam power that there is an immense saving in its use. The difficulty generally met is in governing the water-wheel under spasmodic demands for power. Whatever difficulty of this sort may have been incurred in Spokane, the results seem to have been admirably satisfactory.

An Electrical Sieve. IN every central station there is a keen interest in the subject of lightning arresters. So long as the lines are held in undisputed possession by the currents properly belonging thereto, all is well, but when Dame Nature takes the warpath with her very high tension artillery there is mischief ahead. Divers devices have been tried to tempt the discharge to earth, and we show in our columns this week an efficient newcomer. Mr. Wirt's very ingenious lightning arrester consists merely of a pile of rather thick metallic plates connected alternately to line and earth and separated by a film of some non-conductor. This film is readily punctured by lightning, while the cooling effect of the mass of metal prevents the formation of an arc. Therefore, the lightning will pass harmlessly to the ground, but the discharge will then cease, and the dynamo will not be short-circuited. The contrivance is a genuine sieve that lets through lightning, but holds back discharges of the tensions in regular use. Mr. Wirt does not claim more than is reasonable for his arrester, which seems to be a very simple and effective one, well adapted for general purposes. Of course it is immensely difficult absolutely to protect a dynamo from lightning, since in the case of shunt machines, at least, a very small discharge is sufficient to break through the armature insulation, producing a destructive short circuit. In spite of this difficulty, a good lightning arrester on the lines and in the station can often prevent a great deal of damage to lamps and dynamos.

Safety Fuses. THE paper by Mr. Bathurst which we publish this week handles this important subject in a most practical manner. As every electrician knows, the safety fuse, as generally used, is very uncertain in its action. For some purposes, of course, it is sufficient if the fusible strip or wire will blow out in time to save the machine it is designed to protect; but, in most cases it is highly desirable to know very closely what amount of current the fuse will carry safely. Otherwise there will be likelihood of trouble from fuses blowing out too soon and temporarily crippling the circuit, coupled with a danger of burning out the machine if the factor of safety is, as it is apt to be, rather small. Mr. Bathurst points out very clearly the important fact that fuse wires of alloys that have a low melting point are decidedly uncertain in their action, and holds that the best fuse is that composed of the best conductor among pure metals that has a safe melting point. A pure metal can be trusted to be reasonably homogeneous and to possess very nearly the same physical properties wherever it is obtained. Of the metals that melt at reasonable temperatures tin is the most available, owing to its cheapness and the ease with which it can be obtained in approximately pure condition. Mr. Bathurst has devoted much care to a detailed study of the best dimensions and proportions of fuses of this material, and the curves reproduced with his paper give complete information for designing a set of wire or foil fuses to meet any given conditions. These curves are shown on a large scale, so that they may readily be used in designing, and we feel sure that they will prove of no little value to those of our readers who have occasion to make or employ fuses. Besides the data for tin fuses, figures are given for some fusible alloys, so that these may be used if it chances to be more convenient. The advantages of tin for this purpose are, however, so well set forth that unless there should be in special cases reason for using alloys, it would be advisable, probably, to use the pure metal. Its first cost is very slightly greater than that of alloys, while its greater regularity of action and low resistance are strong points in its favor.

NEW BOOKS.

Electric Transmission of Energy. Gisbert Kapp. Second Edition. London: Whittaker & Co., 1890. Pp. 348, 125 ill. $3.00.

The second edition of this well-known work is now at hand, and should certainly form a part of every electrician's library. The first edition was long since exhausted, and the present one, with its important additions, will be well received. Mr. Kapp's method for the predetermination of the characteristic of a dynamo is now embodied in the volume, and has a distinct historical value as being the first effort at scientific principles of designing that met with practical success. The discussion of leakage introduced by the apt simile of the submerged battery is of great interest. It would, however, have been better to discuss Forbes' rules in considerable detail in connection with this subject, as in the hands of Mr. Ravenshaw and others they have proved to be of great practical value. Having clearly stated the scientific theory of leakage it is unfortunate then to lapse into empirical formulæ. This is Mr. Kapp's besetting sin. No one can state more plainly the modern scientific views as to the magnetic circuit and the basis of dynamo designing, and no one drifts oftener into practical methods that may be characterized as rule of thumb.

Modern magnetic theory is brilliantly summed up in a few prophetic sentences from the second volume of Maxwell's great treatise:

"The problem of induced magnetism, when considered with respect to the relation between magnetic induction and magnetic force, corresponds exactly with the problem of the conduction of electric currents through heterogeneous media.

"The magnetic force is derived from the magnetic potential, precisely as the electric force is derived from the electric potential.

"The magnetic induction is a quantity of the nature of a flux, and satisfies the same conditions of continuity as the electric current does.

"In isotropic media the magnetic induction depends on the magnetic force in a manner which exactly corresponds with that in which the electric current depends on the electromotive force.

"The specific magnetic inductive capacity in the one problem corresponds to the specific conductivity in the other."

No words could be plainer than these, and why they were unapplied for nearly a decade is one of the mysteries of scientific progress.

With this clear statement of the broad principle involved, and the beautiful development of it at the hands of Hopkinson and others, Kapp's method of work seems somewhat unscientific, sacrificing exactness of detail without securing compensating simplicity.

The chapters on motors are very interesting and full of keen suggestions. One point very clearly brought out is the limitation of the theorem that the higher the motor electromotive force, the greater the efficiency. Inasmuch as friction is a constant, or nearly constant, loss, of a magnitude much too great to be neglected, the real point of maximum efficiency will be at a motor electromotive force distinctly less than the electromotive force of supply. Our author rather under estimates the self-regulating power of a pure shunt motor. In American practice a carefully designed shunt winding is found to give better results than the differential winding. In speaking of dynamo and motor designing, Mr. Kapp falls into one curious error—he speaks of the advantage of ample section of copper on the armature for the reason that the permeability of copper decreases the magnetic resistance.

Inasmuch as most authorities give copper as a diamagnetic metal, and even if impure it could scarcely have a permeability appreciably greater than air, the force of this reasoning is not very apparent.

It seems to us that the leakage on lines for the transmission of power is somewhat over-estimated. On American tramway lines it is found quite possible to keep the line insulated so well that the leakage is quite negligible.

Throughout his book Mr. Kapp could have avoided many minor errors by paying a little closer attention to what has been done on this side of the Atlantic. The subdivision of electric power has been successfully accomplished here, and the cases are few in which a dynamo is employed to furnish power to a single motor.

The chapter on the most economical size of conductors is interesting, though the subdivision of motive power renders the problem too complicated to be reached readily in a general treatment of the subject. Each case requires a special discussion in order to secure results of practical value. The descriptive chapters on dynamos are of great interest and Mr. Kapp's plan of describing a few machines in detail is an excellent one, for it gives a far better idea of the principles of dynamo construction than could ever be obtained from a promiscuous assortment of pictures and catalogue descriptions.

In dealing with the subject of tramways, American progress is but briefly noticed, and the whole discussion is inadequate and behind the times. A description of plants erected four years ago is of very little value, except as history.

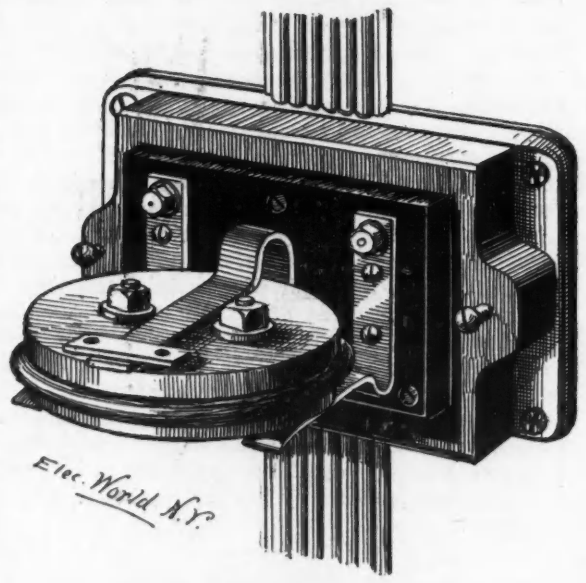
To sum up, this second edition of Mr. Kapp's book is, in spite of the defects noted, a useful addition to electrical literature; and, although the author's peculiar methods are not likely to find many followers, his clear statements of facts and valuable practical suggestions should give to his little treatise a warm welcome from practical men.

Cardew Earthing Device.

Major Cardew's well-known automatic earthing device has been considerably modified by Messrs. Drake & Gorham. We give herewith an illustration of the latest pattern as finally adopted by the London Electric Supply Corporation after an exhaustive series of tests. The necessity for apparatus of this class was foreseen by Major Cardew some time back; and his patents, which are held by Messrs. Drake & Gorham, cover devices which depend for their action on static attraction, or made on the Geissler tube or similar principles. The static arrangement has been found to give good results, and has been adopted in the standard instrument as being less liable to derangement.

The action of the device, as is generally known, is to connect the secondary circuit to earth automatically whenever a dangerous difference of potential is established between the lamp circuit and earth. This result is obtained by interposing some medium that will be of infinite resistance until a high voltage exists, when a free passage for the current is provided.

The static device illustrated consists of two brass plates placed near, but insulated from, each other. Between these lies a thin foil of aluminium, which is retained in position by ebonite pegs. One plate is connected to earth and the other to the secondary circuit. A flat projection is formed on the upper plate, over one end of the foil, so that as soon as a difference of 400 volts is established, one end of the foil lifts by static attraction, and a metallic contact is made between the two plates. The main primary fuses are immediately severed by the increase of current, and the supply is cut off. The two plates are insulated by ebonite rings, and are securely bolted together, so that after being



Modified Earthing Device.

tested at the central station no skilled labor is required to fix them. It has been shown that the plates can be shaken or rolled about without affecting the voltage at which the foil will lift. The plates are carried by brass springs, to which the connections are permanently made at the back of a solid block of ebonite, so that the act of sliding in the plates makes the connections, and a slot on one side renders it impossible to put them in with the wrong side uppermost. The plates are all made interchangeable, so that when the foil has acted it is merely necessary to slide in some fresh plates.

This arrangement has a decided advantage over the method of permanently earthing the secondary. For a strain is in this case permanently put on the insulation of the conductors; and a slight leak, which, with the automatic device, would remain harmless for years, is liable to be developed at any moment into a danger. This is specially the case in damp situations, where the size of the conductor may be reduced by corrosion.

It is evident that the apparatus can be modified to act as a relay, and cut off both poles of the circuit, or to ring a bell and drop a danger disc, as has been arranged for the Chelsea Electric Supply Company, where continuous currents are used.

The Action of Judge Wallace in the Kemmler Case.

The unhappy wretch now under suspended sentence of death at Auburn seems fortunate in his friends if in no other respect. No more neatly efficacious example of the invoking of one law to defeat another was ever shown than in the stay granted by Judge Wallace under which Kemmler's execution is postponed pending an examination of his case by the Federal courts.

Kemmler's friends in this matter are at present anonymous; but that they are powerful is shown by the eagerness of Lawyer Sherman, an eagerness that betokens a fat fee, and also by the astonishing alacrity with which the Assembly at Albany has passed a bill abolishing capital punishment. This bill concerns a matter that has been discussed, canvassed, mooted and argued in most of the legislatures of the world for more than a generation; yet our own remarkable gathering was able to discuss, canvass, moot and argue it, and to pass the bill, all in the space of twenty minutes or half an hour.

Mr. Sherman, who obtained the stay from Judge Wallace, declares that no electrical company is his client; but we regret to see that some of our daily contemporaries refuse to believe his statement, even though it has since been confirmed by the most forcible and positive asseverations of Mr. George Westinghouse. They forget, as it seems to us, that there are 17 other criminals awaiting legal death in this State, each of whom is more interested in Judge Wallace's action than is any electrician. For if the United States Supreme Court shall decide that the electrocution statute is void, as being in contravention of the constitutional clause forbidding cruel and unusual punishments, these criminals stand a fair chance of going scot free. Under what law can they be executed? Not under that now existing, if it is void; nor, it would seem, under the old law, which went out of effect in January, 1889.

Or, from another view point, these men have once been tried; it being a primary principle that no man can be put in jeopardy more than once for the same offense, and their conviction being declared unconstitutional, by what right could they be longer deprived of their liberty?

Does it not seem that we have here a class of persons who would have very good reasons for retaining the services of Mr. Sherman?

Duplex Telephony in Actual Use.

BY A. M. ROSEBRUGH, M. D.

In January last The Electrical World gave a description of a method of duplexing telephone lines, a system devised independently by Mr. J. J. Carty and myself. In this system two parallel trunk lines are joined at each end and connected with a ground line. The two wires are used simultaneously, both as a metallic circuit and as a grounded circuit. Differentially wound transmitters and receivers are used, and with the complimentary coils in both branches of the metallic circuit. One set of apparatus is connected so as to operate in the metallic circuit only, while the other set is connected so as to operate in the grounded circuit only. In working this system a practical difficulty is experienced in giving a subscriber the benefit of the anti-induction metallic circuit system. This cannot be done except by giving said subscriber a double line, a grounded wire, and differentially wound telephonic apparatus.

Realizing this drawback to the system referred to, I have devised an independent system that completely overcomes those objections, and, moreover, obviates the necessity of using differentially wound telephonic apparatus not only at the subscribers' stations, but at the telephone stations as well. This system was devised some time since, but it is only recently that it has been put in practical operation, and a description thereof has never yet appeared in print.

It may be briefly described as follows: At each end of the grounded metallic circuit and in each branch of the same, a repeating coil is inserted. These two repeating coils form a pair, and, taken together, may be called a duplex repeater. These coils are arranged so that electrical impulses generated in the subscribers' circuits may be repeated into both branches of the metallic circuit, equally and in opposite directions. The coils are made with adjustable cores, so as to be able to maintain an equilibrium between the two branches of the metallic circuit. One of the primary terminals of each coil goes to line, while the other primary terminal joins its fellow, and goes to an annunciator and to ground. One of the terminals of the secondary coils goes to a second annunciator and to ground, the other terminal joins its fellow of the complimentary coil, while the remaining terminal goes to ground. This gives two connections and two circuits for switching purposes; for subscribers can use the two wires of the metallic circuit as a single conductor on a grounded circuit, while other two subscribers are using the metallic circuit as a repeating circuit. The first set of subscribers has the advantage of a double conductor while the second set of subscribers has the advantage of the anti-induction of the metallic circuit.

In addition to this, two metallic circuits may be combined so as to form a third or artificial metallic circuit. Duplex repeating coils are placed at the terminals of each metallic circuit; the two terminals of the metallic circuits are joined and a third set of repeating coils inserted. Thus, with four trunk line wires, we get four circuits, three of which are metallic repeating circuits, and one a direct circuit. Toronto and Parkdale are now connected in this manner. Four trunk-line wires are used and four circuits are available for switching purposes. The three repeating circuits are almost absolutely free from induction, although the wires were not designed as metallic circuits, and, notwithstanding the fact that the electric light induction is unusually strong on the single wires on the same route.

The advantage of connecting two metallic circuits in this manner will be more especially realized in long distance telephony when we bear in mind that, in constructing the third, or artificial metallic circuit, we have two wires to form each branch of the metallic circuit, and

that when the direct or grounded circuit is used, the circuit is formed by four conductors.

This duplex system has other advantages. The arrangement of the circuits is extremely simple. The coils are placed on the trunk lines before their arrival at the trunk switchboard; and there is no differentially wound telephonic apparatus required, and no special switchboard arrangements are necessary.

I should add that the Toronto and Parkdale circuits are under the management of Mr. Alexander Stark, of the Canadian Bell Telephone Co., Mr. H. Neilson being the local agent at Toronto.

Electric Lighting of a Railway Train.

One of the greatest improvements recently made in the minor details of adding comfort and safety to railway traveling, is the lighting of cars by electricity, thus at once avoiding the noxious gases produced by the many coil-oil lamps necessary to light the car, and averting, in a large measure, the danger of fire in case of accident.

As in other applications of electricity, so in this, the Pennsylvania Railroad, whose station we illustrate this week, has been in the front rank of the advance. Train lighting is only one of the widely varying means of facilitating railway work by the application of electricity, but it is the one perhaps most familiar to the public, and, from an artistic point of view, the most interesting.

Our lower cut shows the dynamo room, which is on the second floor of the building, close to the passenger station in Jersey City, and is given up to electric lighting. The building is 60 by 75 feet, and the ground floor is taken up by the boilers and engines. There are two Wetherill-Corliss engines of 175 h. p. each, supplied by a battery of four locomotive boilers, which prove very serviceable in their quiet capacity as station boilers.

This arrangement of the station, boilers and engines on the first floor, and dynamos on the second floor, is one that has been largely adopted of late, and has proved very convenient, inasmuch as it places the boilers near to a ready supply of fuel, and puts the dynamos all together in light, airy quarters.

The dynamo room contains eight dynamos of various types. Four of them are United States incandescent dynamos with a capacity of 400 lights each. These are used exclusively for storing batteries used in lighting isolated Pullman cars. There are, beside, four arc machines employed for lighting the passenger station, two of them Brush 30-light machines, one Brush 45-lighter and a Thomson-Houston 25 lighter.

For lighting ordinary Pullman cars the dynamos just mentioned are employed to charge the accumulators, which fit into boxes beneath the cars. The batteries at present are almost exclusively of the Electrical Accumulator Company make, and of the 7 B type. Twelve cells are placed under each car, fitted into trays or boxes, as shown on the left, where is seen the working process of shifting the batteries just before starting the train. Ten lights are provided for each Pullman, two 24-volt, three 23-volt and five 22-volt lamps. The batteries will operate these lamps, to the extent necessary, for ten hours. This service is severe on the accumulators, and it has been the subject of a large amount of experiment to find a battery that should be at once reasonably efficient and durable. The present batteries are calculated to last about a year under ordinary service. Their great weight is, of course, an inconvenience, but by using low voltage lamps, a battery can be employed light enough to be shifted without special difficulty.

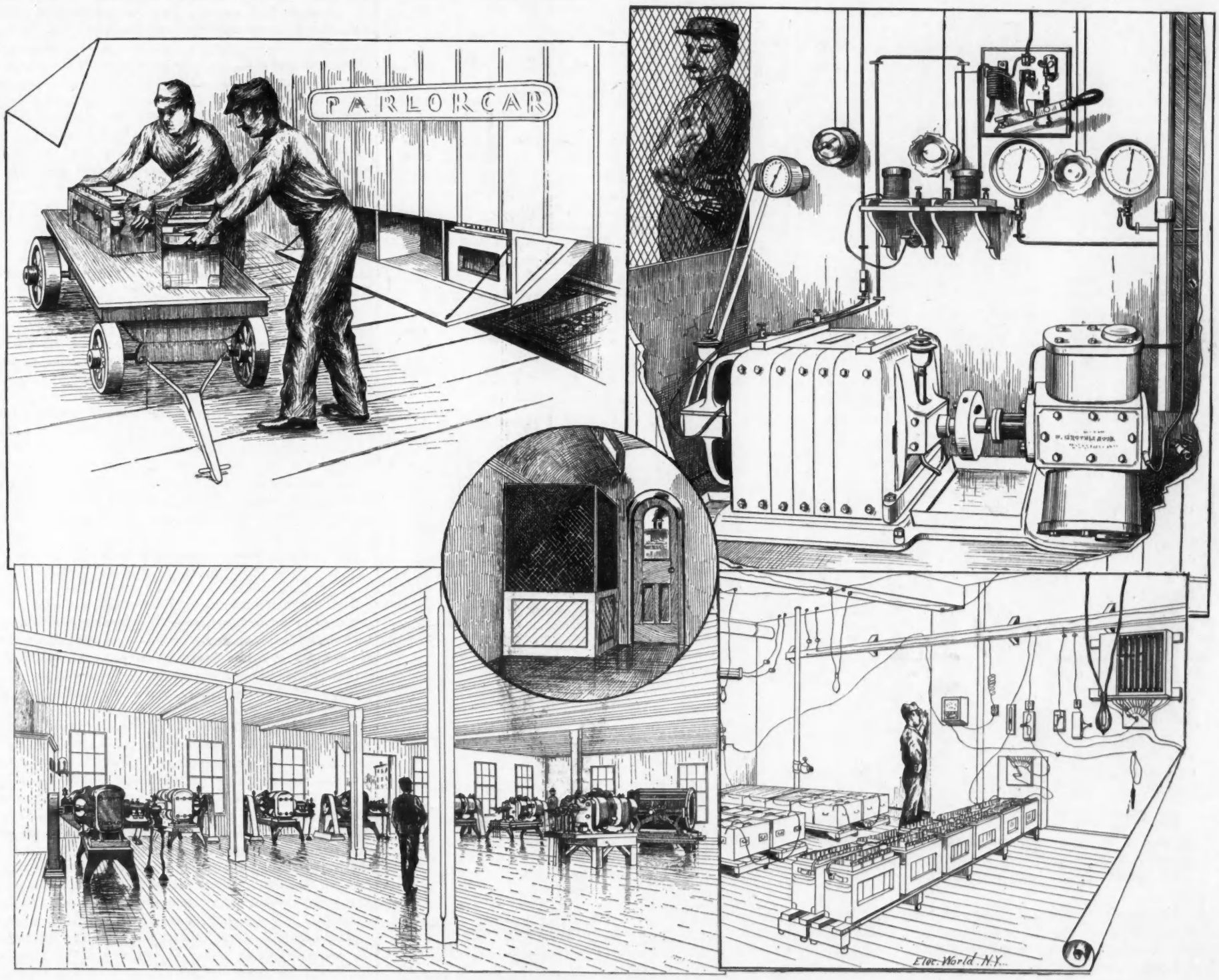
The arrangements just described are for lighting single Pullman cars. On the limited trains, composed exclusively of parlor cars, another arrangement has been found more convenient than that just described. On these trains the storage battery is still used, but is kept charged by a dynamo and engine located in the baggage car. The battery and cells are of the same type as those just mentioned, but more of them are fitted to the car, inasmuch as they do not have to be moved, thus allowing the use of a higher voltage lamp. Thirty-two cells of battery are placed under each car, and the lamps regularly employed are Edison 60-volt incandescents. The battery is really subsidiary on the limited trains, serving to steady the light and light the car in case it is detached for any purpose. As the train pulls out of the station the dynamo in the baggage car is started and kept running practically until the end of the trip, keeping the batteries charged to their full capacity.

The central figure is a corner of the baggage car given up to the little dynamo room, separated by gratings from the rest of the car, and barely big enough to contain the apparatus. The plant in this lilliputian dynamo room consists of an Eickemeyer dynamo, a machine, as will be seen from the cut, of the well-known iron clad type. It reaches a speed of 900 revolutions per minute, and is coupled direct to a 10 h. p. Brotherhood engine. The dynamo and engine were specially designed for this severe service, and the equipment includes a regular switchboard, with the necessary measuring apparatus and chronometer for keeping continuous watch of the speed of the dynamo.

Great difficulty was found in securing the proper engine when this subject of train lighting was first taken up. It is easy enough to find an engine that can be belted to the dynamo, or one that would operate the dynamo at a much lower speed if coupled direct; but belting is unsatisfactory in view of the incessant vibrations, and the small slow-speed dynamo is not easy to obtain. After a great deal of search the Brotherhood engine was fixed upon as perhaps the best, and although the performance is not all that could be desired, it has acquitted itself very creditably in the work. There is room still for an economical engine to run at very high speed by direct coupling. The wonder is that any engine can run successfully at the high speed of 900. Steam is furnished from the locomotive at full pressure.

Those who have had the fortune to ride frequently on the Pennsylvania Limited, or the other limited trains equipped with this lighting apparatus, will thoroughly appreciate the convenience and beauty of electrical train lighting. What has been accomplished has been the result of much steady and persistent study, and it is probable that the end is not yet by any means, and that improvements will go on until steam heating apparatus and electric lights shall be considered a necessity for any respectable railroad.

The pioneering work that we are here describing is certainly very interesting, and its results have been most encouraging. To make electric train lighting universal and practical, a lighter and more durable storage battery is desirable, as it is for so many other purposes; and, in the progress of electrical inventions, it seems well-nigh certain that ere long such a battery will be forthcoming.



ELECTRIC TRAIN LIGHTING, PENNSYLVANIA RAILROAD.

Physiological Experiments with Electric Currents.

BY EDWARD TATUM, M.D.

The following experiments were arranged for the purpose of ascertaining how definite a relation might exist between density of current and fatal result. Dogs were the only animals used. The uniform routine of procedure was to begin, in the case of each dog, with the closure of a current that was not expected to be fatal; and then to follow that with closures of successively increasing strength until the heart was arrested. The duration of each closure was one second. And a subsequent dose was not given until the heart and respiration were apparently quite restored. The electrodes were flexible frames of fine copper wire, covered with a thick coating of absorbent cotton, and were wet with weak salt solution. A round one about two inches in diameter was bound on the forehead, and a rectangular one, one-and-one-half by six inches, was bound upon the inner aspect of the right thigh as close to the body as possible.

The electrical resistance with similar connections, had previously been recorded in twelve dogs of varying weights and build. The highest figure was for a black and tan terrier of about 12 pounds, and reached rather more than 500 ohms; the lowest, for a stoutly-built dog of about 80 pounds, was slightly less than 200 ohms. The resistance offered by dogs between 30 and 40 pounds is, with fair contacts, generally very near to 300 ohms. These resistances were obtained by dividing the total number of volts of potential difference by the number of ampères actually passed. They include, therefore, the obstruction offered by the electrodes, the contacts, and counter electromotive force.

It has clearly been shown by experiments previously published that the fatal mischief done by electrical currents to dogs is done chiefly or entirely within the actual substance of the heart.

I have, however, not thought it worth while to attempt in this place any estimate of the current density to which the heart has been subjected, but have confined my calculations in the following tables, to (1) the average density in the smallest transverse section of the neck (expressed in decimals of an ampère per square inch); (2) the average density in the greatest transverse section of the chest; (3) the ratio of current strength to body weight.

The strength of alternating currents is expressed in virtual ampères and read on a hot-wire ammeter.

The results would, doubtless, have been more satisfactory if, in every case, the interval between the strongest current survived, and that proving fatal, had been less than it now is. Still, it is thought that the results, as presented, are at least sufficient to give a fairly definite notion of the order of magnitude of the currents of different sorts that are required to produce fatal results.

Besides the summary given in Table V., I would call attention to the following points of interest:

First. That 300 reversals per second are no more injurious than 120, with currents of the same virtual strength.

Second. That, when reversed 300 times per second, a current to be fatal need not be of more than half the virtual density of a continuous current for the same result. This is the lowest ratio between the respective "least fatal densities" given in Table V., and occurs when chest densities are regarded. If neck densities or weights are regarded, the lowest ratio of fatal powers is about one-third.

Third. That, when dogs are thoroughly etherized, this difference between the fatal powers of continuous and rapidly alternated currents is practically abolished, the same virtual strength being required in one case as in the other.

Fourth. That while ether thus in some way increases the tolerance for rapidly alternated currents, it has no such power with regard to continuous currents.

Fifth. That, in estimating the killing power of a continuous current, the relative position of the poles is probably without significance.

TABLE I.

WITH ALTERNATING CURRENT.

300 reversals per second.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	Chest.	Ampères per pound of body weight
		Ampères.			
1..	8⅛	.08	.015	.007	.0094
		.18	.035	.015	.0212
2..	11¼	.1	.018	.006	.009
3..	20½	.11	.015	.006	.0063
		.30	.03	.012	.0125
4..	25	.3	.036	.012	.012
5..	26¼	.1	.008	.0026	.0039
		.2	.017	.0052	.0078
6..	27¾	.1	.008	.003	.0036
		.2	.016	.006	.0072
7..	40	.05			
		.17			
		.22	.021	.009	.005
		.245	.023	.01	.0061
8..	47¾	.35	.02	.008	.0073
9..	51	.2	.005	.002	.002
		.1	.01	.004	.004
		120 reversals per second.			
10..	13⅜	.1	.014	.0064	.0073
11..	18½	.1	.014	.0037	.0054

TABLE II.

WITH ALTERNATING CURRENT.

300 reversals per second.

Dogs Etherized.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	In chest.	Ampères per pound of body weight
		.08			
		.15			
		.20			
1	14¾	.29			
		.42	.056	.019	.0285
		.435	.058	.02	.0295
		.03			
		.125			
2.	25	.225			
		.315	.036	.012	.0126
		.45	.051	.018	.018
		.1			
		.2			
3.	25	.3			
		.5	.05	.018	.02
		.75	.075	.027	.03
		.05			
		.15			
4.	40	.225	.014	.0056	.0056
		.36	.023	.009	.009
		.36			
		.50			
5.	40	.60			
		.715			
		1.05	.1	.04 survived.	.026
		120 reversals per second.			
		.02			
		.05			
		.13			
6.	15½	.17	.017	.006	.0087
			.023	.008	.0111

TABLE III.

WITH CONTINUOUS CURRENT.

Furnished by Secondary Battery.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	In chest.	Ampères per pound body weight.
1..	9	.3	.059	.019	.033
		.42	.082	.027	.047
2..	20	.3			
		.4	.041	.015	.02
		.53	.055	.020	.026
3..	36¼	1.07	.074	.03	.029
		.4			
		.55			
4..	59	.9	.044	.017	.015
		1.25	.061	.023	.021
		.3			
		.5			
		.7			
5..	66¾	1.1	.061	.022	.017
		1.1 2 sec.			
		1.1 2 "			
		1.1 2 "			
6..	97½	1.3	.045	.018	.013

In Nos. 1, 3, 6, the positive pole was on the head.
In Nos. 2, 4, 5, the negative pole was on the head.

TABLE IV.

CONTINUOUS CURRENT.

Furnished by Secondary Battery.

Dogs Etherized.

No.	Weight. Lbs.	Current each closure 1 second.	Average current density. In neck.	In chest.	Ampères per pound of body weight.
1..	20	.28			
		.30			
		.48	.049	.02	.024
		.65	.067	.03	.032
2..	45	.37			
		.52	.036	.013	.0115
		.70	.048	.017	.015

In No. 1 the positive pole was on the head.
In No. 2 the negative pole was on the head.

TABLE V.

SUMMARY.

	Alternating current. 300 Reversals.	120 Reversals.	Dogs etherized. 300 Reversals.	120 Reversals.	Continuous current.	Dogs etherized.
Strongest current used	.35	.1	1.05	.17	1.30	.70
Strongest current survived	.22	.0	1.05	.13	1.1	.52
Second strongest current survived	.15	.0	.50	.0	.9	.48
Greatest density in neck survived	.021	.0	.10	.017	.061	.049
Second greatest density in neck survived	.015	.0	.056	.0	.059	.036
Greatest density in chest survived	.009	.0	.019	.0	.019	.....
Strongest current, per pound, survived	.009	.0	.028	.0087	.033	.024
Second strongest current, per pound, survived	.0063	.0	.026	.0	.02	.011
Least density in neck, fatal	.01	.014	.023	.023	.045	.048
Second least density in neck, fatal	.016	.014	.051	.0	.055	.067
Least density in chest, fatal	.004	.0037	.009	.008	.018	.017
Least current per pound, fatal	.004	.0054	.009	.0111	.013	.015
Second least current per pound, fatal	.0061	.0073	.018	.0	.017	.032
Least fatal current	.10	.10	.36	.17	.42	.65
Ratio of greatest neck density, survived, to least neck density, fatal	.21	.0	.100	.17	.61	.49
	.10	.0	.23	.23	.45	.48

Since writing the above, Dr. Tatum has sent to us the following interesting letter bearing on the same general subject and especially important in view of certain experiments the results of which were recently made public in England:

To the Editor of The Electrical World:

Sir: Electrical currents can cause muscles to contract either directly or indirectly, or through the intermediation of motor nerves. They can also cause, through the cutaneous nerves, sensations varying from a rather pleasant thrill to an intolerable pain. The reactions of these organs vary with the sorts of currents used; and the intensity of the reaction in the case of a given organ and a given sort of current, varies to a certain, though limited, extent in proportion to the actual electrical output. These phenomena are exhibitions of normal physiological functions, and depend, for their development, upon the life and integrity of the tissues in question.

Electrical currents may also cause the sudden death of an individual organism. Is the latter power a simple extension of the former one? Do they kill individuals by virtue of physiological excitation of muscles or sensory nerves? It seems to be generally assumed that such is the case, and that if we can find out what sort of currents will, for a given electrical outlay, most vigorously call forth this vital activity, we shall then have found the kind of current that will, with the least expenditure of energy, destroy the individual.

It is certain, however, that the death of an individual (dog) may be produced without the intermediation of sensory nerves; for some currents can kill quite as readily as ever after all sensibility to pain has been abolished in profound ether anæsthesia. And it is equally certain that it is not any muscular contraction caused by the current that kills. For the heart, which is the most vulnerable of all the vital organs, and which can be killed by currents that leave the other muscles and nerves apparently uninjured—the heart is actually not caused to contract by a fatal current, but is robbed of its faculty for further contraction.

If, then, the fatal power of electrical currents has no discoverable connection with their power to excite to physiological activity in senses, nerves or muscles, what right have we to accept a comparison between the painful sensations caused by two different sorts of currents, or between their capacities for exciting muscular contractions, as the *measure* of their respective powers to destroy the function of a totally different organ? Certainly, none whatever. If one sort of current really has a greater killing power for the same mechanical equivalent it can only be established by direct experiments with currents that kill; and the greater or less irritation which cutaneous nerves may suffer, in mild applications, is totally irrelevant. Respectfully,

Yonkers, N. Y. Edward Tatum, M. D.

A Simple Storage Battery.

The following directions for making a simple storage battery are due to the *Journal of the Telegraph*. Get two half-round porous cups and a round glass jar large enough for the two porous cups to stand in upright. Get two plates of sheet lead one-sixteenth of an inch thick, wide enough to fit the half-round side of the porous cups and deep enough to come an inch or so above the top edge of the cups and jar. Solder a stout copper wire or a screw post to each lead plate at the top. Place the lead plates in the cups and fill the cups nearly full with a paste made of red lead mixed with a solution of sulphate of soda thin enough to run like a cement. The glass jar containing the two cups should be filled to within half an inch of top of the cups with sulphuric acid and water, about one part of acid to eight of water. The plates should be marked so that, in charging, the currents may be sent in the right direction. The cell may be charged by attaching it to a series of a dozen sulphate of copper cells for 24 hours, or from a dynamo. A wooden cover may be fitted to the glass jar, and evaporation of the fluid should be replenished by adding water. Two or more cells of this battery will work small motors, lamps and induction coils, and if thoroughly charged will retain a large volume of electricity for a considerable time. After once being well charged, four to six cells of sulphate of copper battery will recharge it.

A Large Domestic Plant.

The Société Electrique of Brussels, which works the Julien system of accumulators, has just made an important installation of the electric light in the palace of the Comte de Flandre at Brussels. The lighting includes at present three arc lamps in the State court yard and 900 incandescent lamps, divided as follows: 178 in the library, the dining hall, the billiard room, and the prince's private apartments; 574 in the reception rooms, 27 in the guests' chambers, 28 in the children's apartments, and 93 in various other rooms. The primitive installation of the motive power, placed in the cellars, included in the first place a 4 h. p. dynamo for charging a battery of Julien accumulators for serving the private apartments only. This has been increased by the addition of a 20 h. p. dynamo for charging a battery of 36 accumulators. These are charged every eight days, according to need. This plant, which is entirely supplied by accumulators, allows the light to be had at any hour without setting the engines to work. The success, it is said, has been so great that the Comte de Flandre is now preparing to light the entire palace, which will raise the total installation to 1,500 lamps.

Spokane Falls Electric Railways.

No better evidence of a city's push and readiness promptly to accept anything that facilitates business exists than its street railways. Spokane Falls, Wash., has now in operation four systems of street railways running over 16½ miles of track, and before the middle of summer will add 25 additional miles, making 41½ miles of railway in and around the city.

The Ross Park Electric Street Railway Company was incorporated on July 17, 1888, with a capital stock of $80,000, and afterward increased to $150,000, the entire cost of the road being $300,000. The system used is the Thomson-Houston, and the people are well satisfied with its workings. The cars are of the finest make.

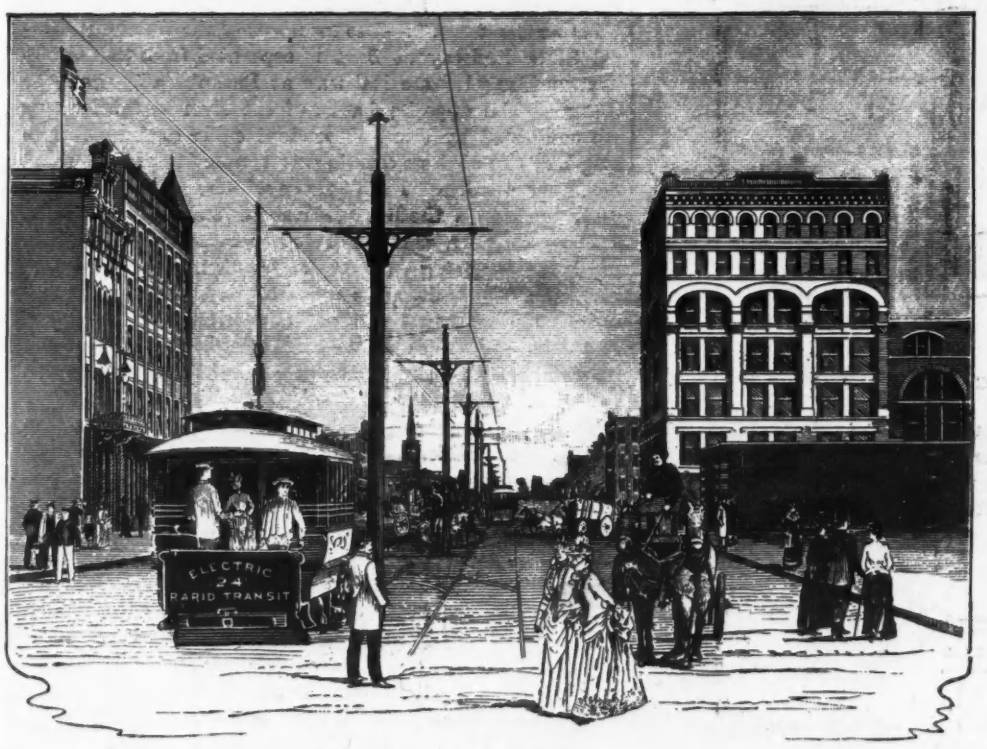
The roadbed, upon which the ties and 500 tons of steel rails are laid, was brought to exactness of grade. Heavy railroad ties are placed 2 feet apart and the 30-pound Joliet steel rails are firmly secured to them. So carefully and solidly has the road been constructed and ballasted that it is regarded as extremely fast and safe. It is mainly level, the heaviest grade being at the bridge, where it is 4½ per cent. The average grade is less than ½ per cent. The poles are 100 feet apart, and 30 feet long. They are neatly painted and ornamented with gilded cross brackets. On the tip of every other pole is placed a cluster of five 32-candle power lights, which brilliantly illuminate the line from end to end.

The motive power is furnished by a 225 h. p. Victor horizontal turbine, built especially for the company on the most approved pattern. The fall of the water is 39 feet, and by the penstock and draft tubes the water is discharged 8 feet below the bed of the river blasted out for the purpose. The power is then transmitted by pulleys and belts to counter shafting, which is set on solid masonry, and from there to the generating machines, 60 feet above the river. This room contains the principal electric apparatus, consisting of two 80 h. p. generators, readily capable of operating 16 cars. The collective power is 160 h. p. The machinery is exquisitely made. The various devices for managing and manipulating the current are beautiful works of mechanism. The station is supplied with every improvement and invention necessary to thoroughly successful operation. Each car is supplied with two 10 h. p. motors, and can be propelled by one or both.

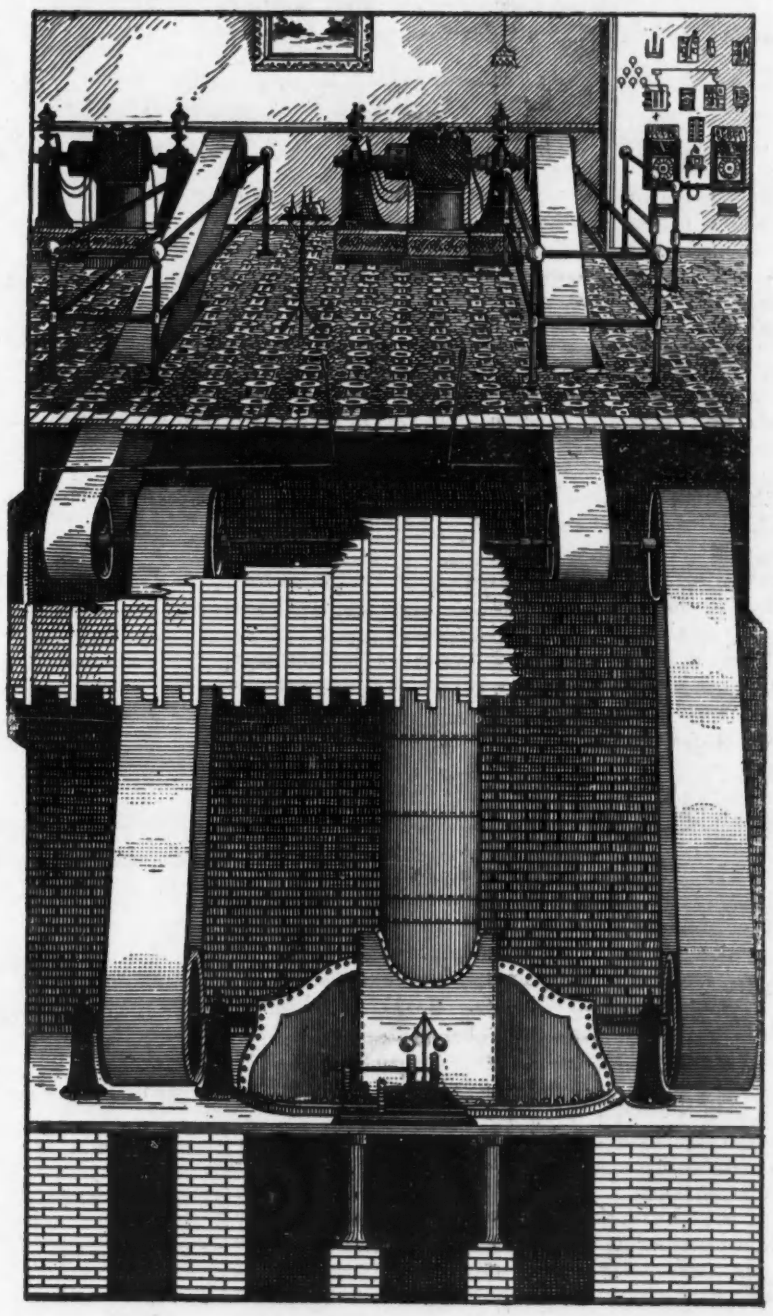
The car house is located midway between the ends of the line.

The road was opened for public travel on Nov. 17, 1889. Upon that day 4,980 people were carried in the course of forty-eight trips—every car running absolutely upon time. The past winter has been the hardest winter known in this country for years; more snow has fallen than for the past collective five years. The same enterprise and public spirit that have characterized the construction of this elegant road was repeated in the operation of the road during this inclement and snowy winter. In spite of the heavy snow fall and drifting, the road has been kept open, the company after the heaviest fall employing as many as 200 men day and night shoveling; this in addition to the use of snow plows. At one time, for a period of 106 hours, the cars were run day and night continuously. Although the expense has been enormous, this road, from the day of its opening, has not lost a trip, and has run its cars closely on time. In all the time it has run there has not occurred a single accident to a human being. The plant was installed by Mr. H. D. Scribner, the Thomson-Houston expert, whose services the company succeeded in retaining as superintendent of the road.

The City Park Transit Company is a new line, running into the suburbs and making easy of access the comfortable and cheap home locations around the city. The Thomson-Houston system is used by this road also. Spokane Falls is rapidly developing all electrical facilities. Their electric street lighting is a novel and ingenious feature, and is but an illustration of the enterprise of its citizens. We give a cut illustrating the electric street railway, and another showing an interior view of the power house. This is one of the very few successful attempts to supply electric energy from water power, and our neighbors in the Northwest are to be congratulated upon having accomplished that in the trial of which so many have failed.



ELECTRIC RAILWAY, SPOKANE FALLS, WASHINGTON.



HYDRAULIC POWER STATION, SPOKANE FALLS.

Train Lighting in Switzerland.

The application of electricity for the lighting of railway trains is a problem that yet remains to be satisfactorily solved; but, notwithstanding this, many experiments are being conducted in various localities to arrive at a definite decision. The most recent to take up this subject were certain Swiss engineers, who have been making comparative tests with the electric light, oil lighting, and the Pintsch system of gas lighting. The experiments took place in a carriage attached to a passenger train which travels between Zurich and Richtersweil. The carriage contained one first class and two second class compartments, and a toilet cabinet. One incandescent lamp was suspended from the middle of the roof of each compartment, and one glow lamp was also placed on each platform at the end of the car, the two latter lamps being only in circuit when passengers entered or departed from the carriage. The battery was placed in a box under the floor of the vehicle, and weighed 3 cwts. It consisted of eight cells, and contained sufficient energy to last for 18 hours, when it had to be recharged. The results obtained from the experiments were that a 6 C. P. glow lamp is equal to an ordinary oil lamp; but this was considered to be insufficient. A 10 C. P. incandescent lamp, however, enabled the passengers to read with facility small newspaper print when the lamp was provided with a good reflector.

On Signaling Across Rivers in India.*

BY W. F. MELHUISH, MEMBER.

Rivers that intercept lines of telegraph are crossed either by means of ordinary wires supported on masts of wood or iron, or by means of cables; and experience has not only shown that the former method is preferable, but also that the life of a river cable in India is a very precarious one. However, in the case of rivers of greater breadth that can be spanned, cables must be employed. The mian causes that affect river cables will be but briefly noted here; they are:

1. Deterioration of the shore ends by changes of temperature affecting the dielectric.
2. Damage from anchors of ships and steamers.
3. Alteration of the channels and cutting away of the banks.
4. Damage to the dielectric by lightning.
5. Imperfectly made joints.
6. Attacks by white ants and rats.

It not unfrequently happens that a river cable fails entirely, or becomes imperfect, at a time when, owing to the force of the stream, a new cable cannot immediately be laid, or when there is no readymade cable available, or when a considerable period must elapse before the new cable can reach the river. To provide for these contingencies, attempts have from time to time been made in India to signal across rivers without cables, and it may be of general interest to know what has been done in this respect by myself and others.

Three different methods appear to have been discussed and attempted, viz:—

1. Signalling through an imperfectly insulated wire.
2. Signalling through an ordinary bare wire.
3. Signalling without any metallic conductor.

More than thirty years ago Mr. Van Rees, between Portsmouth and Gosport, in salt water, and subsequently Dr. Gintl in fresh water, tried to signal without a wire but the result was in each case a failure, and was supposed to be so because the resistance through the earth between the two groups of earth plates on the same side of the river was too small as compared with the resistance between the two groups across the river. For success it was assumed to be necessary to bury the two groups of earth-plates on each bank from a quarter to a half-mile apart, and to connect them by thick insulated wire. In India, about the year 1858, Mr. Blissett acted on this plan, and obtained a fair measure of success by employing land lines of considerable length on either bank of the river. In the year 1876 the late Mr. Schwendler made some experiments across the river Hooghly at Barrackpore, near Calcutta; and subsequently, during September, 1879, the late Mr. W. P. Johnston, electrician, made the following experiments:

On Sept. 9, 1879, he attempted to signal across a broad canal *without* any metallic conductor. Fig. 1 is a diagram of the connections, etc.:

E = 10 Bunsen's cells joined in series:

R, a needle instrument having a resistance of 1 ohm, also a Bell telephone having a resistance of 4.25 ohms;

W = a resistance of 1 ohm,
e = four Minotto cells joined parallel.
} This arrangement exactly balanced the natural current through the receiving instrument.

A, B, C, D were copper plates, 8 feet 8 inches by 4 feet 4 inches, by $\frac{1}{16}$ inch thick, buried on the banks of the canal. B was buried 15 yards distant from A, and D was

*Paper read before the Institution of Electrical Engineers, April 10, 1890.

buried the same distance from *C*. All the plates were buried parallel to the canal. The resistance between *A* and *B* was 7.5 ohms, and that between *C* and *D* was the same. Under these conditions both the needle instrument and the telephone (used, of course, as a telegraph, and not as a speaking instrument) gave distinct and readable signals.

After several days of experiment with the second method (Fig. 2) using a single bare 600-pound per mile galvanized wire, the following results were obtained:

E = 15 Bunsen's cells in series;

R, a polarized Siemens relay of 21 ohms resistance;

e = 4 Minottos joined parallel } Balanced the natural
W = 10 ohms } current.

The measured resistance of the circuit was + 2 – 20 ohms. The signals received were quite regular and safe;

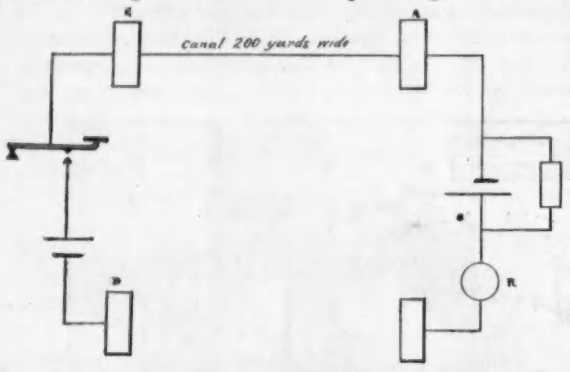


FIG. 1.—SUBMARINE TELEGRAPHING WITHOUT A WIRE.

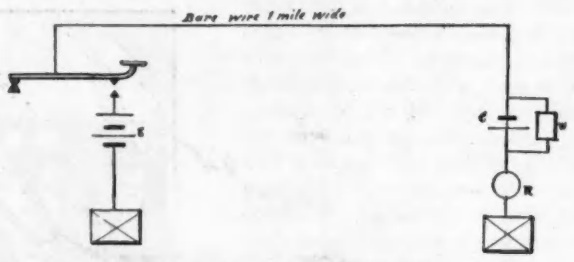


FIG. 2.—SUBMARINE TELEGRAPHING WITH A BARE WIRE.

the tongue of a relay worked an ordinary sounder in local circuit, and no difficulty was experienced in balancing the natural current through the relay. To balance this natural current is a most important element of success in this mode of telegraphing.

Subsequently three miles of the same wire were laid along the canal, the wire having previously been passed through a mixture of pitch and tar, and for the hour the instruments were in circuit perfect signals were received.

The experiment with the bare wire for a distance of one and a half miles was not successful; and as it appeared that in order to obtain signals, the battery power would have to be increased as the square of the distance, the limit through which signals can be received on bare wire under water is very soon reached.

During May, June and July of the year 1888 Mr. Johnston made a long series of trials across the canal and the river Hooghly, and the subsequent measurements and experiments led him to come to the following conclusions, viz.:

That up to one and a half miles it is perfectly easy and practicable to signal through a bare wire under water.

That for greater distances, judging from experiments, it is not possible to signal in this manner.

In April, 1889, Mr. W. P. Johnston died, and the duties of electrician were entrusted to me. Having studied the recorded labors of my predecessor, and learnt that by pursuing the same lines it was hopeless to expect to be able to signal through a bare wire across a river that had a greater breadth than one and a half miles, I resolved to change the class of signalling apparatus and to continue the experiment. Discarding continuous steady currents and polarised receiving relays, I adopted Cardew's vibrating sounder, and the sequel will show how completely successful the change of instruments proved to be. I began from the beginning, and tried to signal across a water-way without a metallic conductor by laying down two earth-plates on each of its opposite banks. Readable signals having been exchanged, the distance separating each pair of plates was varied, with the view of ascertaining how close the plates might be brought together, the signals remaining still readable. Readable signals were exchanged when the distance separating the plates was equal to the breadth of the river, reading becoming more difficult as the plates were made to approach each other, and clearer and more distinct as the distance between the plates was made to exceed the breadth of the river. I learnt from these experiments that in order to obtain signals of sufficient distinctness for the practical purpose of transmitting messages, it would be necessary to construct a line on each bank of a river much longer than the breadth of the river; and as the rivers along the coasts in India are extremely wide, I became impressed with the impracticable character of such an undertaking, and decided to strike out a new line. This new line was the laying of two bare uninsulated iron wires across the water-way parallel to each other, and separated by a certain distance, the ends on each bank being looped together by means of an insulated conductor. Hence, though much of the circuit was laid under water, it was nevertheless a continuous metallic circuit. Beginning first with a complete square, by laying the wires as many yards apart as the river was wide, signals were instantly exchanged that were incomparably louder than those that were exchanged when the same area was bounded by four earth-plates. The length of each of the two wires under water was next gradually increased to 740 yards, and the distance separating them gradually diminished to 35 yards, the strength of the signals diminishing proportionately, and ceasing to be readable when the wires were further prolonged. The conclusion arrived at from these experiments was that, for the practical and useful purpose of signaling messages across a broad river in the absence of an insulated cable, a complete metallic circuit was at least desirable. Acting on this conclusion, it was sought to apply it practically, and the following experiment was carried out: At a distance of 15 miles west of Calcutta a cable is laid across the river Hooghly, which at this point is 900 yards wide. The iron guards of this cable were employed to form one of the metallic conductors, and at a distance of 450 yards down stream a single wire, weighing 900 pounds per mile, was laid across the river to form the second metallic conductor, insulated land lines having been run up to loop the two parallel conductors together. The experiment was quite a success, the signals being readable without difficulty.

An experiment was next made on a defective cable across Channel Creek, at the mouth of the river Hooghly. This creek is crossed by two cables laid in the same trench; the length of each is 3,000 yards, and one of them had been completely parted by a steamer's anchor. Several attempts were made to signal across by using the guards of one of the cables as a lead, and the guards of the other as a return wire, but the efforts proved unsuccessful owing to the too close proximity of the cables. For every cable crossing there is a certain minimum distance apart at which the cables must be laid, and if this minimum, which depends on the breadth of the river, be exceeded, an absolute short-circuit becomes established. But although it was not possible here to signal through the iron guards, the most perfect signals were passed through the two conductors when they were formed into a loop, notwithstanding the fact that the two ends of the broken conductor were exposed in the sea and were lying at a considerable distance apart. An experiment was now made in order to ascertain what chance there might be in the future signaling across the two conductors, should an accident occur to the good cable. Accordingly the conductor of the good cable was disconnected in the cable-house from the signalling apparatus and placed upon the ground, when the signals, though greatly diminished in volume, still continued to be distinctly readable. It may, therefore, be reasonably inferred that should the good cable suffer a similar fate to that of the defective cable, communication can, by means of Cardew's sounders, be kept up by looping the ruptured conductors until arrangements can be made for laying a new cable or repairing the defective ones.

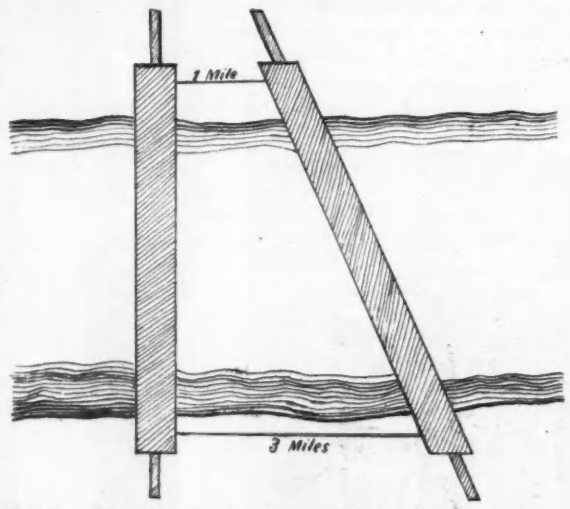


FIG 3.—TELEGRAPHING ON THE SHIELD OF A CABLE.

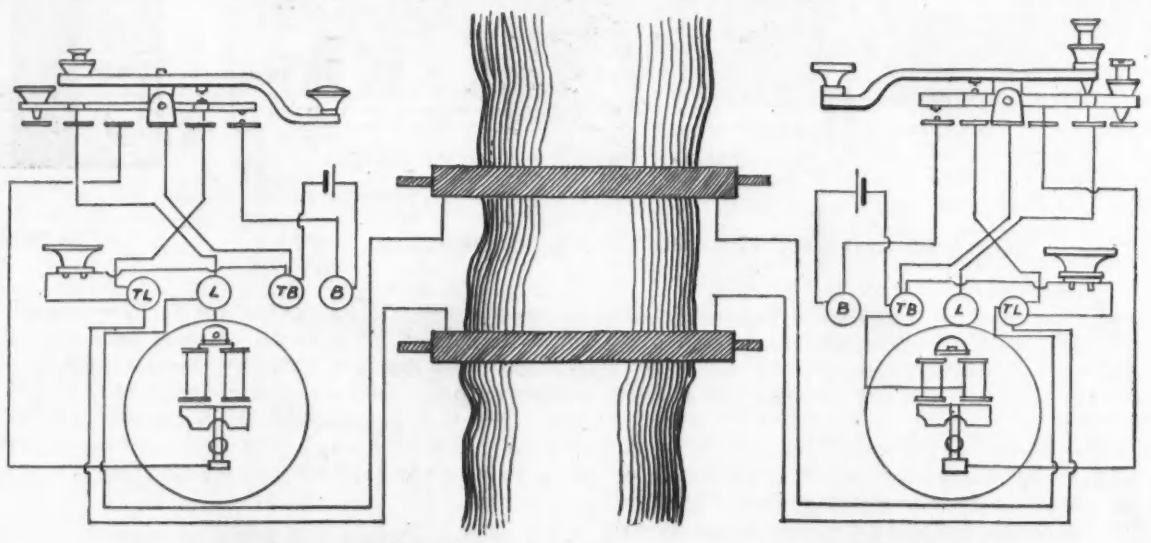


FIG. 4.—APPARATUS FOR SUBMARINE TELEGRAPHY OVER BARE WIRES.

It will probably suffice if from the succeeding experiments that were made to test the efficiency of the vibrating sounder in the case of conductors breaking down at river crossings, I select the following three, exhibiting as they do progressive evidence of the value of this signalling instrument, and culminating in establishing it beyond dispute as one that can be relied on for carrying on independent communication through the iron guards of cables while the insulated copper conductors form parts of other circuits.

Experiment No. 1.—The local line from the Central Office, Calcutta, to Garden Reach is about four miles in length, and at about midway the wire spans a small river. Vibrating sounders having been put in circuit at each end of this line, the wire where it crosses the river was taken down and laid along the bed of the water-way. Signals were loud and clear at both ends.

From the success of this experiment it may be inferred that on any ordinary line, should the wire from accidental causes come off the insulator and make earth by touching the bracket, standard, or ground, or should the wire break and both ends of it be lying on the ground or in a watercourse, communication could still be maintained by means of the vibrating sounders.

Experiment No. 2.—The line wire which connects the town of Chandernagore with Barrackpore is about 10½ miles long, 900 yards of which consists of a cable laid across the river Hooghly. Vibrating sounders having been joined up in the telegraph offices at Barrackpore and Chandernagore, the insulated conductor of the cable was thrown out of circuit, and the line wire on each side of the river was joined to the iron guards of the cable; thus for a length of half a mile out of 10½ miles the conductor was wholly under water, yet it was found quite feasible to transmit messages between the two offices.

From the success of this experiment it may be reasonably inferred that in the case of certain cable crossings, where the rivers are not too wide, should the copper conductor of the cable make dead earth or become insulated by parting, communication could still be kept up between the two offices on either side.

Experiment No. 3.—The terminus of the Northern Bengal State Railway at Sara is separated from that of the Eastern Bengal State Railway at Damukdia by the river Ganges. The opposite banks of the river in this locality are connected by two independent cable crossings. The length of one of these crossings is 1 mile 610 yards, and of the other 4 miles. The distance which separates the two cable houses on the Damukdia side is 3 miles 1,584 yards, and on the Sara side the cable houses are only 1 mile 211 yards apart, giving a mean lateral distance in alignment of 2 miles 880 yards. The two cable houses on each bank of the river have an insulated connecting land line. The two cable crossings and the connecting land lines form an irregular metallic circuit somewhat resembling that given in Fig. 3.

The connecting land lines having been joined to the iron guards of the cables, two vibrating sounders were placed in circuit, one on each side of the river, when signals so strong were transmitted across that it was not difficult to read them at a distance of six feet away from the receiving telephone.

From the marked success of this experiment it may be inferred that at all river cable crossings where the cables are laid in separate alignments (and the farther apart the better), should the cables become interrupted, communication may still be maintained from bank to bank by using vibrating sounders, thus avoiding the delay, inconvenience and cost of boat service.

It should also be remembered in the case of such a parallel cable crossing, that besides the circuits afforded by the copper conductors, when these are in working order, there is always an additional local circuit available by means of the iron guards between the opposite cable houses, and that this circuit could be used by means of the vibrating sounder as a talking circuit, in cases of necessity, without interrupting through working on either of the cables.

Each of these three experiments may properly be described as a delicate experiment. With so much of the conductor under water, the quantity of current which reaches the receiving telephone is so infinitesimal that signals could not be successfully transmitted if the vibrator were joined up in the ordinary manner. It is desirable in circumstances similar to these to reduce all the resistance external to the actual connecting lines to as small a quantity as possible, and therefore when messages are being transmitted, the telephone at the sending end should be removed from the circuit, as also should the vibrator from the receiving end. To effect this twofold purpose a special form of signaling key (designed by the writer) is requisite, and should be used. The action of this key, together with the complete set of connections for a parallel cable crossing, is shown in Fig. 4.

A Compact Motor.

The annexed cut gives a very good idea of the new high power motors manufactured by the C. & C. Electric Motor Company, New York. Many of the motors used to be made with field magnets of the ordinary straight form. At present, however, the magnetic circuit of all motors, from 1 h. p. up, is made in a circular form, the field magnets forming a hollow cylinder with rounded edges, through the centre of which passes the armature. The pole pieces project from the cylinder and embrace the armature. This form of field has been adopted as giving the minimum practical magnetic resistance and consequently requiring a comparatively small amount of energy to keep up the field. In spite of the fact that the closeness of the fields to the armature may produce more or less leakage, the general leakage of the machine is considerably reduced by the fact that no part of the field magnets has any sharp corners or angles from which leakage could occur, so that a compact form is secured without the serious leakage that is likelyso often to attend it.

The cut represents a 25 h. p. C. & C. motor of this type. It weighs 2,000 pounds, thus giving a weight efficiency that is very satisfactory. All the larger sizes like this are fitted with self oiling bearings, or sight feed oil cups, as occasion may demand. The speed is, owing to the strong field secured here, relatively slow, that of a 25 h. p. motor being 850 revolutions per minute. For many purposes this slow speed is a distinct advantage, inasmuch as it is not necessary to reduce the speed by belting to any great extent. The tests of this new and powerful form of motor have shown very satisfactory efficiency, and the entire construction seems to be such as to secure a reasonably light, compact, and efficient motor, excellent electrically, and, what is of equal importance, well designed mechanically. There is a large field for such motors, and the present machine will doubtless meet with wide application.

Safety Cut-Outs and Fuses.

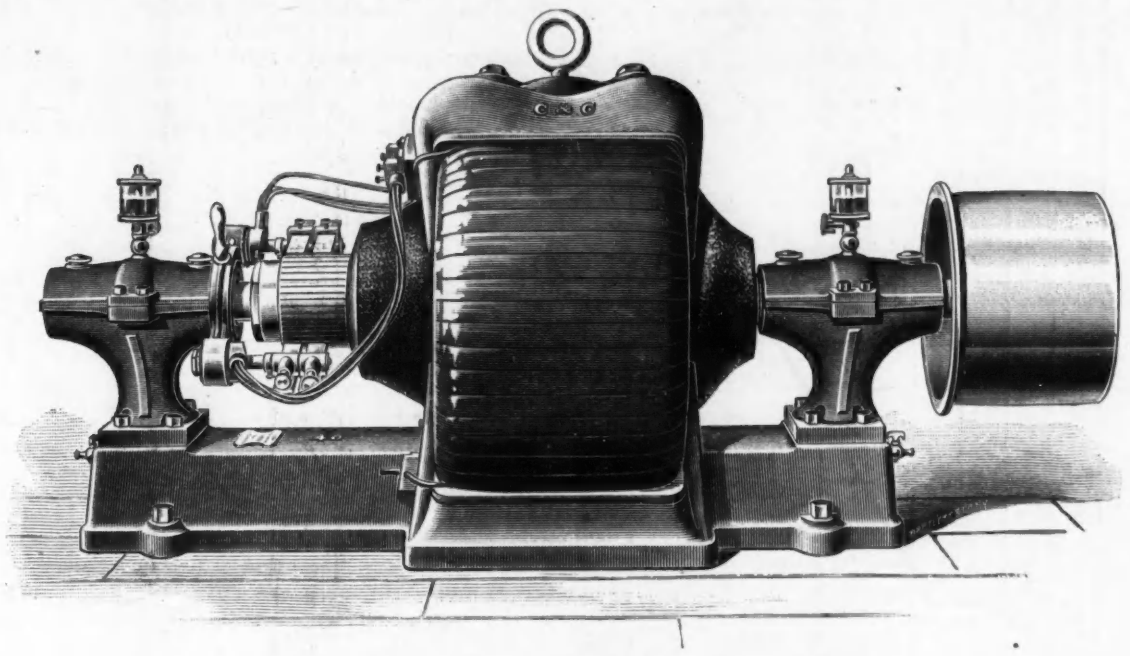
BY FREDERICK BATHURST.

Fire office rules and inspectors, as well as experience, render it necessary that all installations of electric light should be properly equipped with safety cut-outs or fuses, to make sure that the conductors be protected from any overheating caused by excessive current. Everyone that has had to deal with the fuse slips and fuse wire of the present time knows what uncertainty prevails as to their exact fusing point (what current passing through them will break them), and this uncertainty is only increased when the wire or slip is sold according to its "carrying capacity" or its "light capacity." With the object of gaining some definite information relative to the exact current required to fuse lead alloy wires and tin and lead wires (so as to break the circuit), a number of experiments have been made and results obtained.

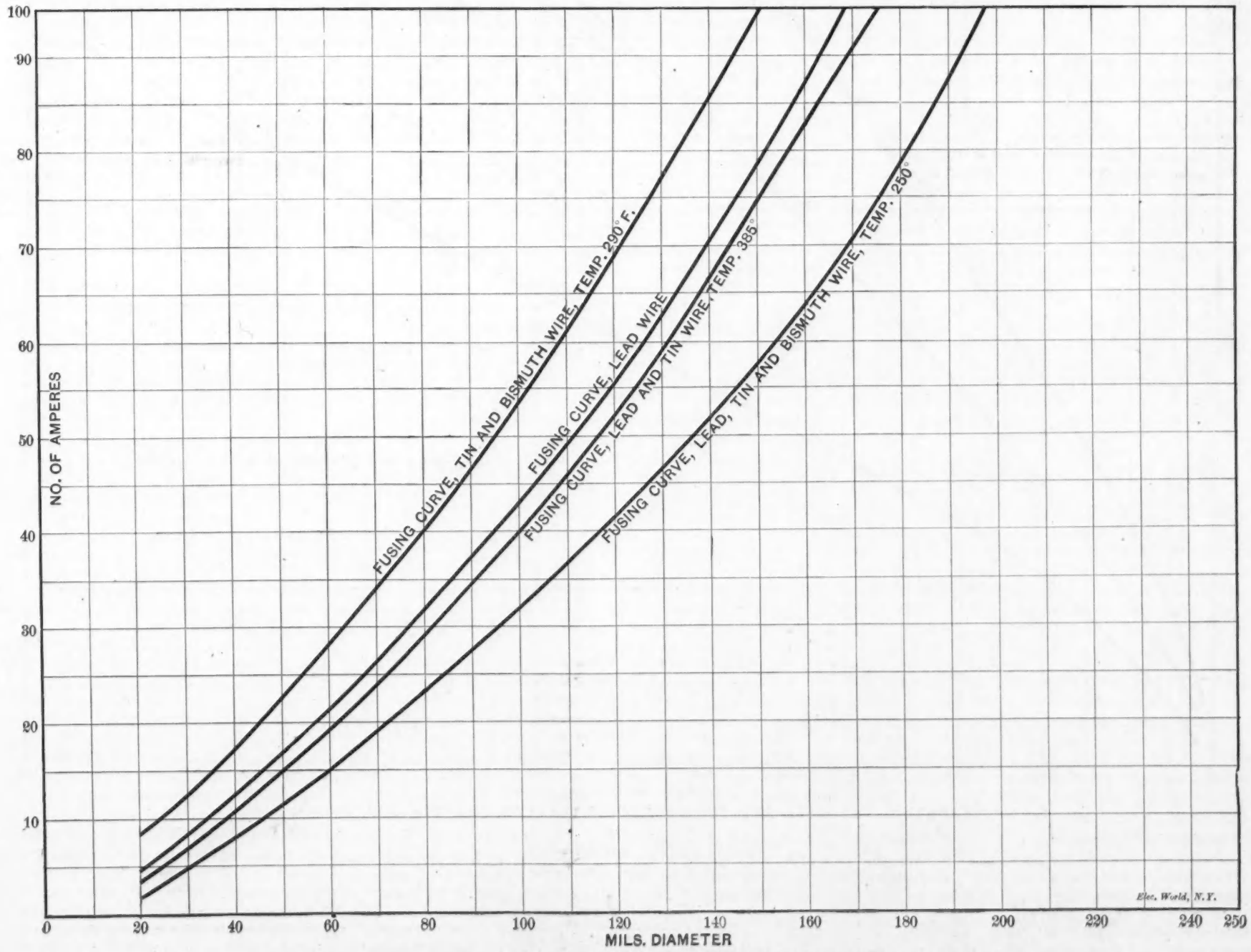
A current flowing through a conductor heats it (in the case of copper according to a known law) and it is this heating that it is desired to keep within limits. The better the conductor the less the heating, so that the ideal fuse wire is the best conductor, melting at the lowest relative temperature.

It is known that a lead alloy can be made that has a much lower melting point than that of any of its single constituents, for whereas tin melts at 432 degrees Fahr., bismuth at 480, lead at 620 and antimony at 800 degrees Fahr., an alloy of these metals can be made that will melt at 199 degrees Fahr.; and although the relative resistance of alloys is higher than that of the pure metals, the fact of such a low melting point being obtainable would point to to the conclusion that of a lead alloy we can form the best fuse.

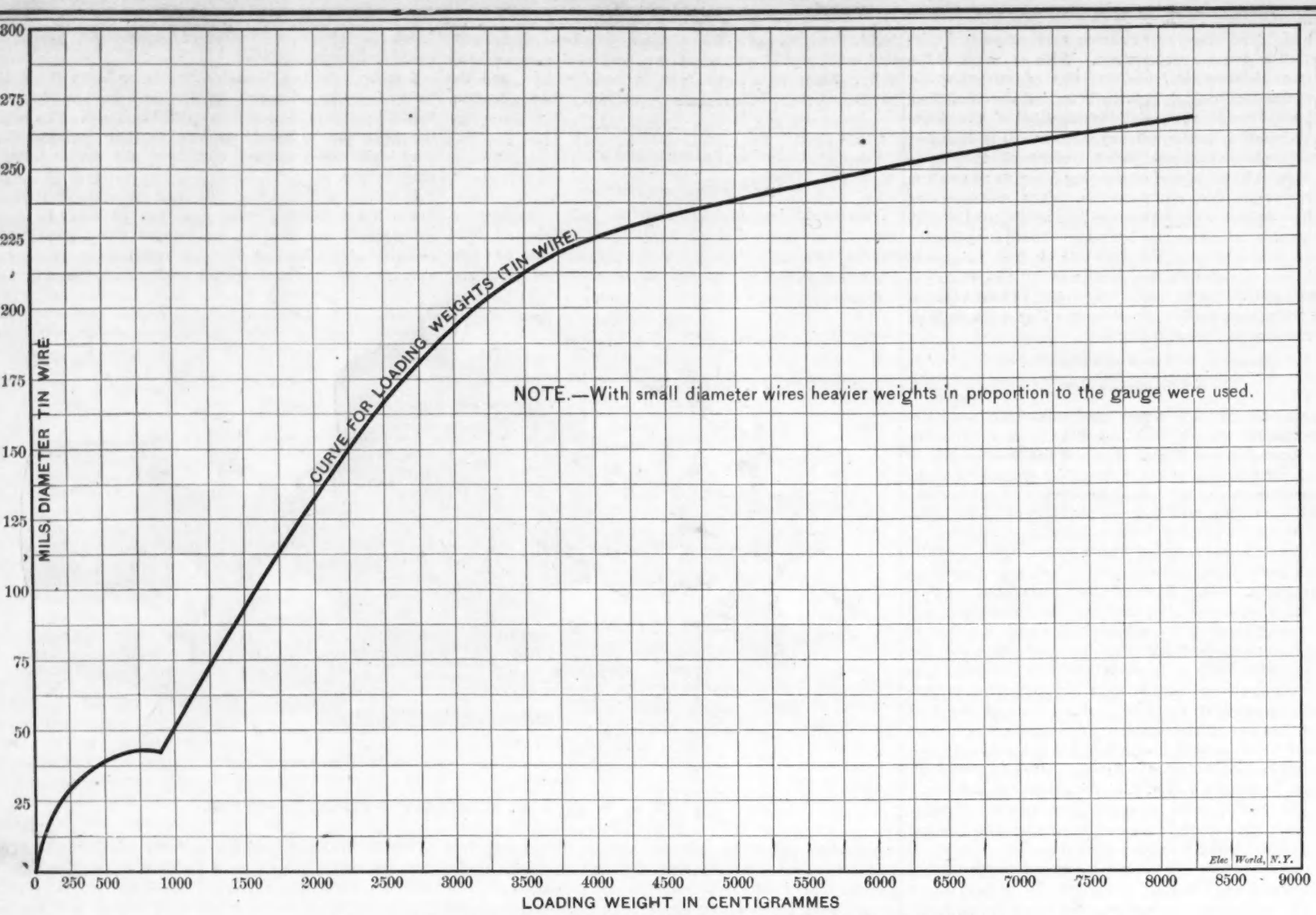
With this idea several alloys were obtained marked to fuse at certain temperatures, and endeavors were made to draw them down into wires of different diameters, but with only partial results, as those that were most easily



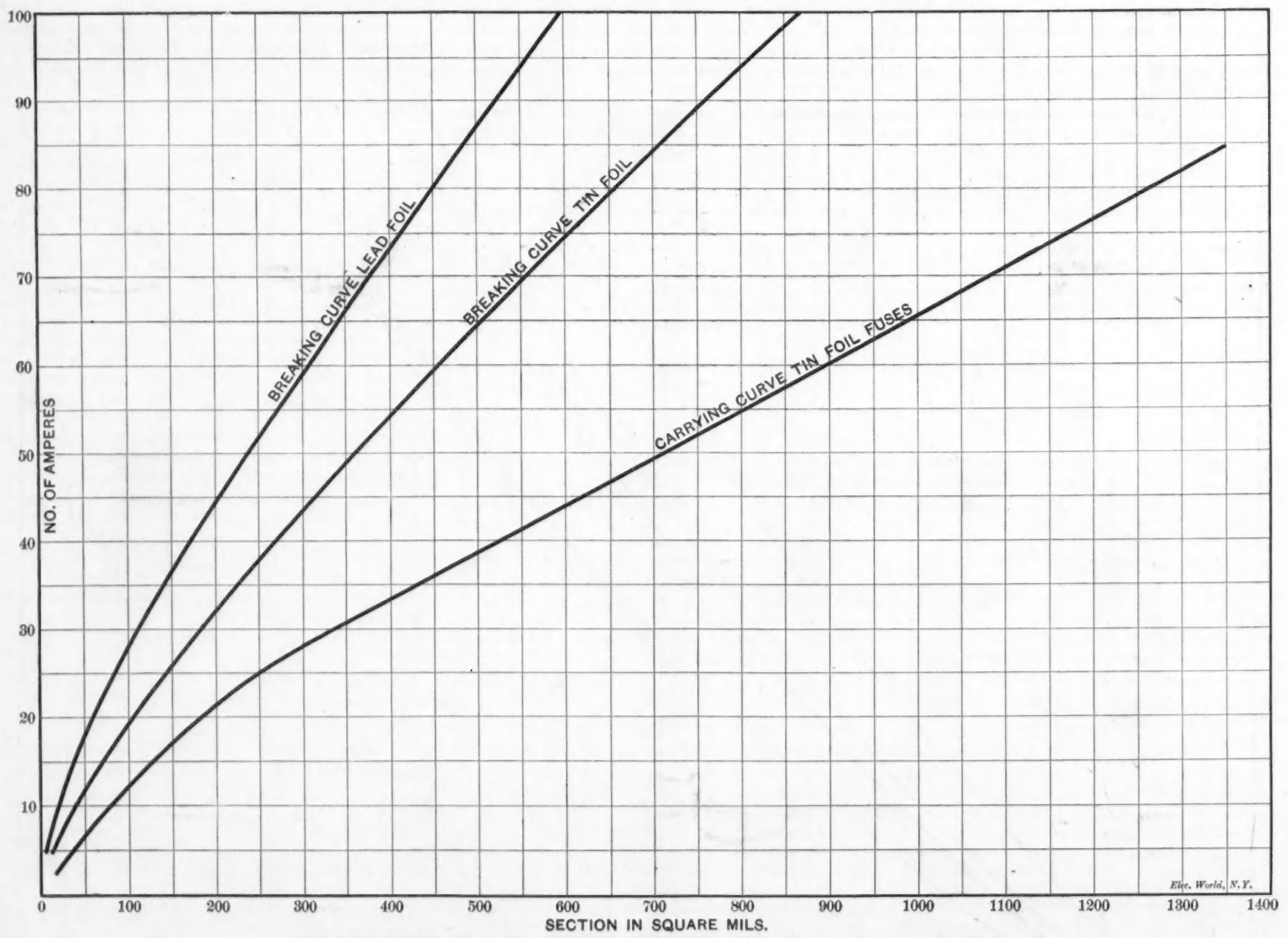
25 H. P. C. & C. CONSTANT POTENTIAL MOTOR.


NO. OF AMPERES
MILS. DIAMETER
FUSING CURVE, TIN AND BISMUTH WIRE, TEMP. 290° F.
FUSING CURVE, LEAD WIRE
FUSING CURVE, LEAD AND TIN WIRE, TEMP. 385°
FUSING CURVE, LEAD, TIN AND BISMUTH WIRE, TEMP. 250°
Elec. World, N.Y.

RELATION BETWEEN DIAMETER AND FUSING CURRENTS, LEAD AND ALLOY WIRES.



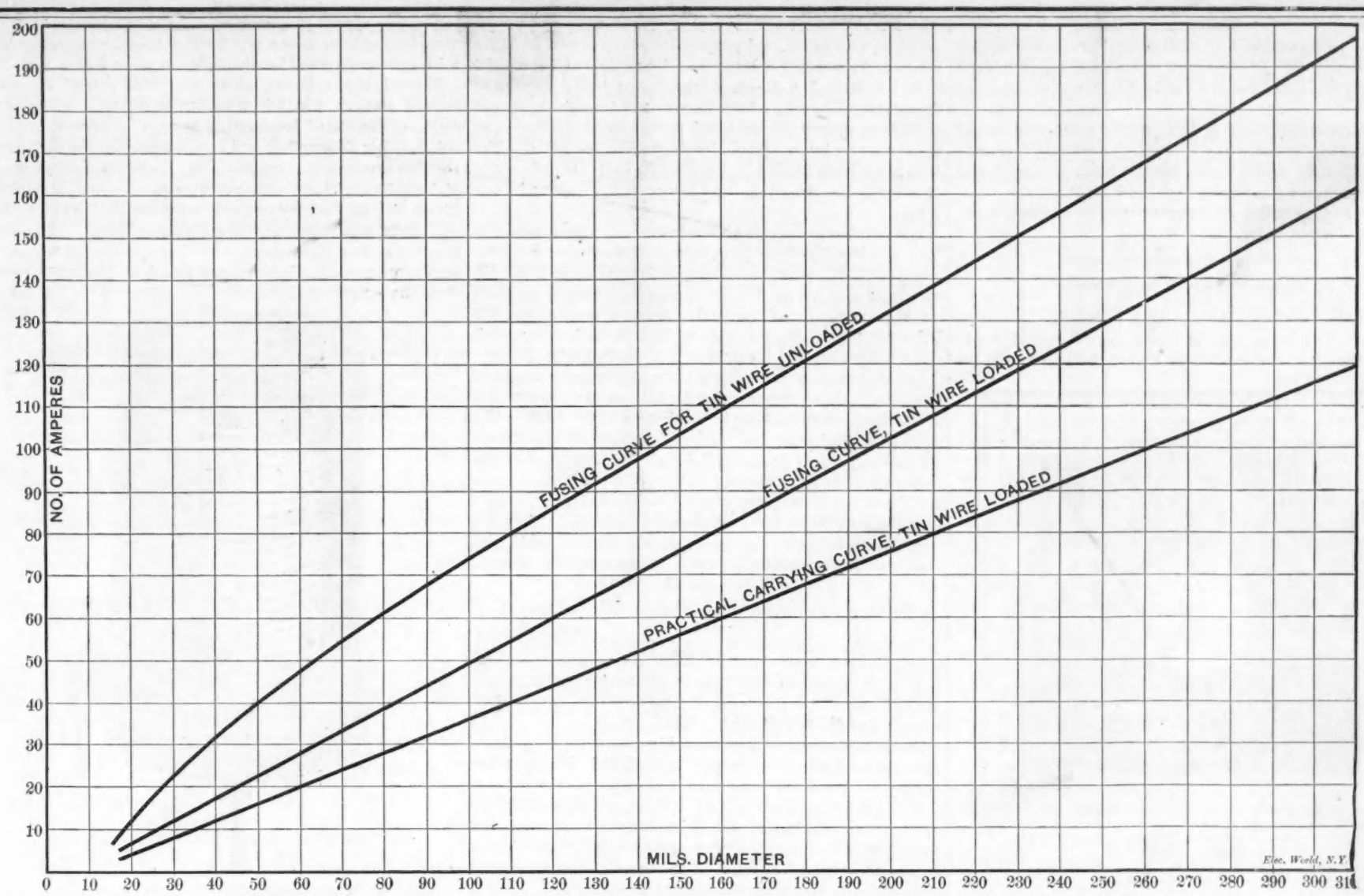
BEST WEIGHTS FOR LOADING TIN FUSE WIRES OF VARIOUS DIAMETERS.



CARRYING CAPACITY AND FUSING CURRENTS, LEAD AND TIN FOIL FUSES.

fusible could not be drawn in the finer gauges, becoming either too weak or too brittle for practical use; for a commercial fuse wire should be one that is easily manufactured and that will withstand the rough usage of actual practice.

It would be almost impossible to give anything like exact tabulated results of experiments with these easily fusible alloys; as it was found that although a wire of a definite diameter of a certain alloy was fused by a less current than that required in the case of a pure lead or tin wire, no trustworthy observations could be obtained, as the size of the clamping terminal and the length of the wire between the terminals produced great variations. For instance, a wire of 36 millimetres diameter could be fused with 12, 11 or 8 ampères, according as the length between the terminals was increased from ¼ an inch to 1¼ and 2 inches. Increasing the length increased the certainty as to the actual fusing current. The time taken to fuse the wire also greatly affected the results; bringing the current up slowly seemed to make the fuse-wire stand all the longer. Another noticeable point was that the same fusing current required a greater volume or mass of metal (that is,



CARRYING CAPACITIES AND FUSING CURRENTS—LOADED AND UNLOADED TIN FUSE WIRES.

thickness of wire); so that it was probable that the actual number of heat units generated while fusing the wire was quite as great as the number generated in fusing a wire of less diameter melting at a higher temperature; and in view of the fire-office requirements that all cut-out blocks and bases must be of non-combustible matter, it was held that the finer wire was not so disadvantageous.

Curves were plotted showing the connection between diameter and fusing currents for wires of a tin and bismuth alloy (half and half), melting point 290 degrees Fahr.; lead and tin alloy (half and half), melting point 385 degrees Fahr.; lead, tin and bismuth (half and half), melting point 250 degrees Fahr.; the reading being determined from the aggregate experiments. Pure lead and pure tin were employed, and, although the same modifying circumstances came into play in the case of lead, they were not so marked in the case of tin. In the above cases the terminals were of ample size, so that no heating could take place in them, and the current was brought gradually up to that required to break the wire in intervals of about 10 minutes, using 1 inch lengths in the small wires and 2 inch lengths in the larger.

All fuse wires will carry for a short time a rush of current even 25 to 30 per cent. in excess of that which, flowing gradually, will break them.

It was noticed that foil or strip fuses, possibly on account of greater radiating surface, were more trustworthy than wires. Results are tabulated, showing the relation between the sectional area of lead and tin strips and the fusing current.

Experience pointed to the advantage of the use of pure tin over all lead alloys or lead, on account of the ease in working it and obtaining it. It is a better conductor than any of the other easily fusible metals (if copper is 98 tin is 12, lead 8, antimony about 8, bismuth 1.25), and at the same time has a lower melting point---tin 432 degrees, bismuth 480 degrees, lead 620 degrees, antimony 800 degrees, Fahr. Another advantage in its adoption as the standard fuse wire would be that it can easily be recognized by the strange sound it gives out when bent, familiar in the "tin cry" of the best solder. The wire in different diameters could easily be obtained almost anywhere, and all electrical supply houses and hardware dealers could keep it in stock; it does not oxydize greatly in the air, and the white oxide that forms on its surface when a large current has passed through it would serve as a guide to point out that the fuse was overloaded. The retail cost of these raw materials used for fuses is a very small matter compared with the amount chargeable for the labor in working them up. Anyone buying tin wire could have a fair idea as to the current that will fuse it, although to say to a certainty would still be impossible unless the fuse blocks had been tested with different diameters of wire. The only fuses with which it was possible to obtain exact results (within 5 or 10 per cent.) were the weighted fuses (Cockburn's patent), which consist of a tin wire loaded with a shot in the centre so that the wire breaks when in plastic condition.

The same end could be obtained by means of a spring in compression or other device, and a table is given showing the weight required for a certain diameter and the fusing current. It is useful to compare this with the table for unweighted tin wires.

During these experiments several of the faults and disadvantages of the fuses in ordinary use became prominent, chief among which was the liability to bad contact between the wire and the binding contact terminal of the fuse block. This increased the uncertainty, and was sufficient in some cases to cause the fuse to melt with a current 50 per cent. less than the normal. To obviate this, all short fuses should be provided with a metal connecting piece of copper or brass in the form of either a tag or an eyelet. The time taken to replace a broken fuse was apparent, and the Edison screw socket fuse, though cumbersome, was found the quickest to replace, although a neat form could be made by mounting the wire on a refractory material and fastening the ends to brass rings, the whole sliding in between contact jaws.

Mechanical means of making contact were found to be preferable to connect the fuse material with the connecting plate, provided the surfaces were clean, as soldering, etc., introduced another element of uncertainty.

Fusible junctions seem imperative; but when all is said and done they are not very effective as magnetic devices. An experience of the writer's may serve to illustrate this: A lamp in a room at the top of a building was short circuited, which caused its protecting fuse to blow, and the main magnetic cut-out in the engine room in the basement went also, causing all lights to go out. The main cut-out was immediately put back, and the lamps relighted, and on examination it was found that the current had affected the main magnetic cut-out after passing over all the branch fusible cut-outs, four in number, without fusing them!

Electric Railroads in the Census.

The use of electricity as a motive power for street cars will be an important section of the census investigation of the electrical industry. None of the many forms of the application of electricity has been developed more rapidly or been accompanied by more satisfactory results than that of the transmission of power for street car purposes.

The census investigation of the general subject of transportation has been very properly assigned to Prof. Henry C. Adams, statistician of the Interstate Commerce Commission. He has divided the subject in several sections, one of which is "Rapid Transit in Cities." This section has been assigned to Special Agent Charles H. Cooley, a son of Thomas M. Cooley, Chairman of the Interstate Commerce Commission.

The plan of investigation that has been adopted is designed to make a comparison between the different motive powers employed—animal, steam dummy, cables and electricity—to show the relative economic value of each. Electricians can wish for nothing better than this. Street railroads are now being transformed into electric roads as fast as manufacturers and construction companies can take care of the business. How they will manage with an added impetus given to the business, is hard to predict.

The schedules for the section of rapid transit in cities will include the inquiries to be made regarding electric railroads. That part of the schedules pertaining to the electrical branch of the subject, will be prepared under the supervision of Allen R. Foote, special agent, and that portion of the report pertaining to the use of electricity as a motive power for street cars will be embodied in a report on the investigation of the electrical industry, as well as in the report of the section making the investigation.

The Census Office is performing a service of great value for the public in making such special investigation. All who have to do with questions of municipal management of public affairs are keenly aware of the necessity of securing trustworthy data by which to guide their actions. The cost of obtaining such statistics through the Census Office, is but an infinitesimal tax on the capitalization of the industries interested, while its impartial and impersonal character gives it the weight of an unquestioned authority.

A Large Contract for Electric Car Trucks.

The McKee syndicate, which controls the large Rochester street railway system, has just closed a contract with the well-known Peckham Company, of New York, for 100 cantilever trucks, which are to be fitted with Short motors for use on the Rochester road.

Epileptic Electricity.

An amusing case of causeless alarm occurred in New York on April 29. A big crowd gathered in Chambers street, just west of Broadway, to watch the struggles of a policeman and a lineman with a supposed live electric light wire. The policeman was striking the wire with his club, while the lineman lay on his back in the middle of the street, clinging to the end of the wire with both hands and apparently suffering from an electric shock. Pretty soon a man handed an axe to the policeman, who hacked at the wire until it broke. The lineman's face was purple, and he trembled from head to foot. An ambulance was called and he was carried to the Chambers Street hospital. The policeman subsequently reported the case as one of a cross between a live and a dead wire, and even went so far as to declare that he experienced a severe electric shock when the axe touched the wire.

The facts of the case, as we are informed by the surgeon who was in charge at the time, and by Mr. Charles Ford, superintendent of the hospital, are that the lineman had an unmistakable epileptic fit, including all the well-known symptoms, and that his hands showed no burns, as had been stated; and further that there was no evidence of any kind that he had been in contact with a live wire. His own account of the matter (which he was well enough to give fifteen minutes after reaching the hospital) is, that he was coming

down the pole and had his hands on no wire, when he felt a slight dizziness. In falling he probably grasped a dead wire; but his illness was the cause of this action and not its result.

The absurdity of many of the reports circulated about the danger of electric wires is neatly shown by this incident. It is time to emphasize the far greater, unseen and insidious dangers of escaping gas, rather than the occasional and preventible accidents caused by carelessness in handling electric wires.

An Automatic Clock and Cut-Out.

Companies supplying electric light to private consumers find that much unnecessary waste of power and of lamps takes place from carelessness in regard to shutting off the

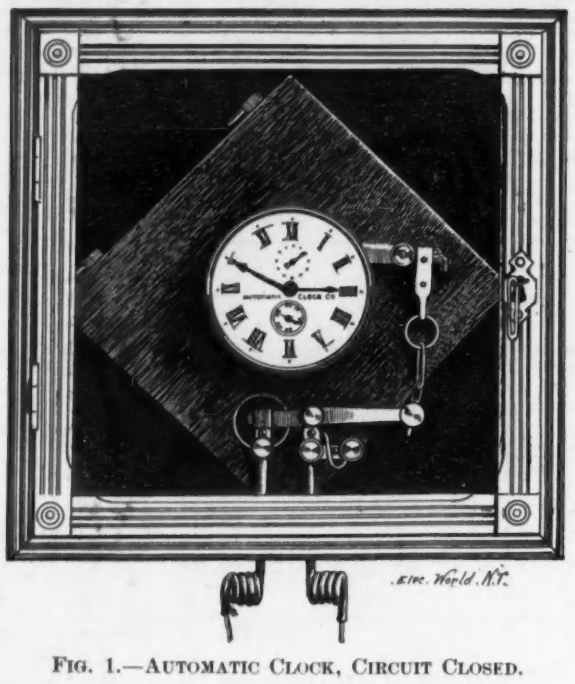


Fig. 1.—Automatic Clock, Circuit Closed.

light when not in use. Thus a shop window, which it is desirable to keep lighted up to nine or ten o'clock in the evening, often has its lights burning all night, because there is no one to put them out; or, on dark mornings, when the light is needed in some parts of the shop, it is often left burning throughout the building, the clerks saying, "it doesn't cost any more," and not taking the trouble to turn it off in the front part of the store. Sometimes lamps are allowed to burn all day Sunday in the same way.

The meter will not check this tendency to waste—or rather, will check it in a way equally unsatisfactory to the companies. A merchant on an all-night circuit would often rather do without the light in his windows than in-

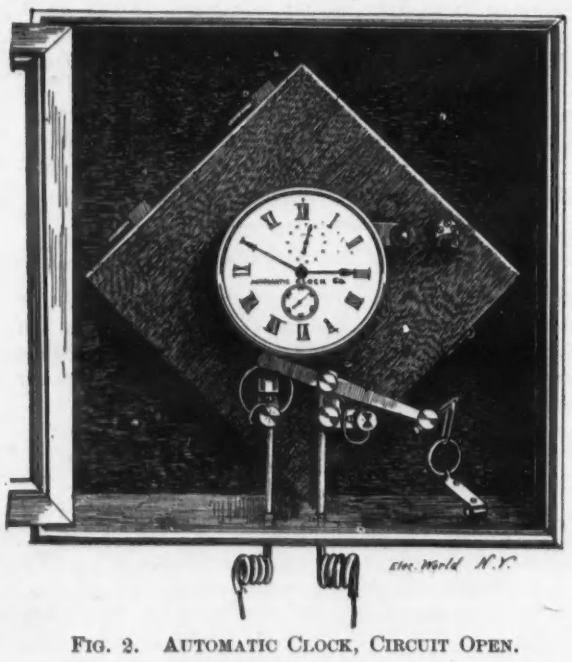


Fig. 2. Automatic Clock, Circuit Open.

cur the necessity of visiting his shop at ten o'clock every evening to turn off the current, and if aware that unless he does so a meter is piling up a big bill for useless night-light, he simply refuses to employ electricity at all; the company loses a good customer.

The Automatic Clock Company, of Syracuse, N. Y., puts forth a device that seems to solve these difficulties in great measure. Their clock cut-off is simple and effective. It does not act electrically, but by simple gravity. A bracket, or inclined track, mounted on a board to the right of the clock, supports a roller connected with a switch. The roller is kept in place by a bar drawn from the clock and resting against the track (Fig. 1). At the set time the bar slides into the clock; the track being clear, the roller drops and a spring, connected with the switch, breaks the circuit (Fig. 2).

The clock will switch out any number of lights, arc as readily as incandescent. It is a valuable friend to the electric light station, in the fact that there are in every large city many persons that will use electric light when they find that they can get it (and pay for it) only one, two or three hours every evening. Many merchants now use the light from 6 P. M. to 8 A. M.—from the closing to the opening of the stores. The only reason they do not turn the lights out at 10 P. M. is that it is too much trouble to go to the store in person and too uncertain for an employé to do so. The result is a large bill if a meter is used, and a useless waste of lamp to the consumer and power to the station in any event.

The automatic clock is also valuable for running motors for a specified time and to enable stations to combine both a 10-o'clock circuit and an all-night circuit on one line. By running a loop for the 10 o'clock circuit, and placing a clock on this loop, the 10 o'clock customers cannot use the light all night. Better still, a clock in each consumer's place will switch out his light at any desired time.

The duplex clock made by the same company consists of two mechanisms, one arranged to form the circuit at a given time, and the other to break it at a later hour. The duplex is desirable for motors in public buildings, where the janitors do not feel interest enough to shut the motor off after office hours.

These clocks, we should think, are destined to fill a very important niche in the electric light business. They are now on exhibition in the display of the United Light and Power Company in the Equitable Building in this city.

Brooklyn Institute—Department of Electricity.

We learn that, greatly to the regret of both faculty and students, Prof. Spice has been obliged to sever his connection with the Institute. His final lecture on electrical measurements was delivered on Saturday last, the subject being "The Energy of the Current."

The professor stated that the subject was very formidable and serious, and, commercially considered, of great importance. He defined the term "energy" as the rate at which work is performed, and in this connection explained the word correlation as coined and used by Grove. The principles of the dynamo were explained and illustrated by means of an induction coil. A thermopile was used to illustrate the relations between heat and electricity.

The professor stated that as the dynamo was not directly the subject, he would confine himself absolutely to the question of heat; starting with heat and ending with electricity. He stated that any force could be exchanged for another; that correlation was not fixed, but could be changed at will. By means of a current from the Edison station, and of special apparatus constructed for the occasion, the production of heat by electricity, and of electricity by heat was shown, and their mathematical values clearly explained on the blackboard, In demonstrating the fact that heat is produced directly as the resistance, the professor made use of exceedingly unique and novel apparatus. In a vessel or trough containing kerosene was placed a coil of wire of a given resistance.

A second and smaller trough contained exactly one half the quantity of kerosene in the larger, and in it was placed a second coil of just one-half the conductive resistance of the first, the two being connected serially in circuit. In circuit with a delicate astatic galvonometer was an especially constructed thermopile, its connections dipping alternately into the liquid in either trough. By passing a current of 7 ampères through the coils for several minutes it was clearly proven that the heat produced in one trough was exactly as that in the other, as no current was generated in the thermopile, although the needle was violently deflected when one of the troughs was removed.

Prof. Spice also practically demonstrated that it required the same amount of current to fuse a short as a long section of wire, and concluded by explaining the unit of heat as related to horse power.

At the conclusion of his lecture a vote of thanks was unanimously tendered the professor for his able and instructive efforts. On Saturday, May 10th, papers will be presented by different members of the department; and on the 17th instant will be given a lecture by Mr. A. E. Webb on "Submarine Cable Laying."

The number of students in the department, stated by us as 80, is in reality 180. We gladly add to the corrections our hearty congratulations upon this measure of success.

A New Lightning Arrester.

The serious and frequent losses from damage to electric light apparatus due to lightning have stimulated inventors to unusual efforts to find means for overcoming the difficulty. Of late years, as tensions have increased and circuits have lengthened, the simpler and older forms of lightning protectors have been found to be inefficient, and more elaborate devices have multiplied, until now the list is so large that one might think that the inventors of car couplers had turned to a new field. We illustrate the latest addition, which has been put on the market by the Electrical Supply Company, of Chicago, and has been patented by Mr. Charles Wirt. It is very modest in appearance, and on internal analysis presents the virtues of extreme simplicity. It is claimed that while affording the readiest possible path to earth for all static discharges, it is quite impossible for the dynamo current to pass when the arrester is properly designed for the tension it is to be used with. This is accomplished not by any operative device, but by the cooling effect of a large mass of metal with numerous small breaks.

The cut, Fig. 1, shows the arrester with part of the case broken away. Fig. 2 is a section in which *A* is one of a series of insulated conducting discs; *B*, a mica disc; *C*, a bolt holding all together and connecting the top disc with the line through the leading wire; *D*, an insulating tube; *E*, insulator; *F*, base which is also the ground terminal. It will be seen that by properly covering the terminal end of *C* there will be no conducting parts exposed. In some situations this is an important feature of safety. The breaks between the discs are only about .002 inch in width. Thus the aggregate distance to be bridged by the lightning

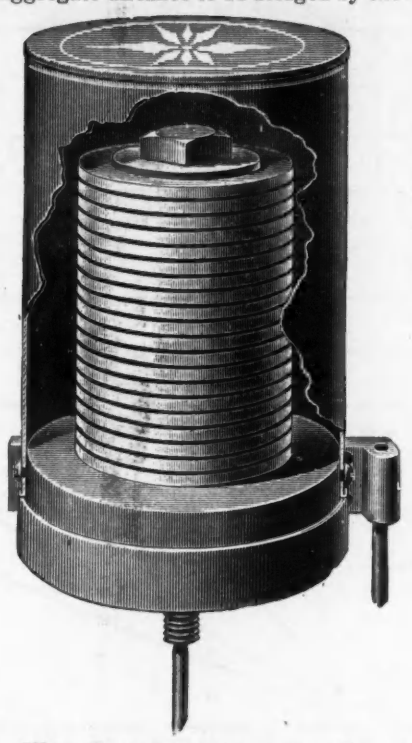


Fig. 1.—Wirt Lightning Arrester—Perspective.

spark is less than the single break in many arresters. The principle is a most beautiful one, and its effectiveness is best shown by starting an arc from a high tension dynamo over the surface of the arrester in any convenient manner. This cannot be done in the ordinary way with an induction spark, but it can be shown that a current that will maintain an arc 4 inches long in the air will not hold an instant when divided by the breaks of the arrester, although the aggregate length of all the breaks will not exceed $\frac{1}{20}$ of one inch. This arrester is recommended for indoor or outdoor use on all classes of currents and wherever protection is called for. As it needs no fuse, and no inspection, and is weatherproof, it is better suited for use outdoors than most

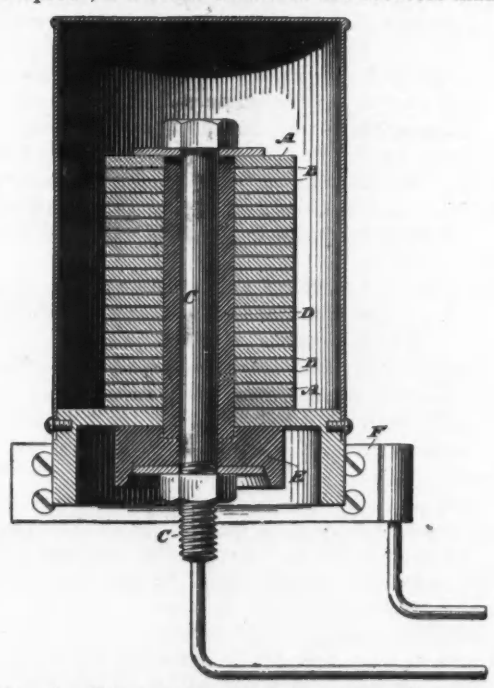


Fig. 2.—Wirt Lightning Arrester—Section.

devices. The difficulty of getting good service out of an arrester on poles has led to dependence being placed on arresters placed in the station. There is no doubt that lightning should be kept as far as possible away from dynamos, no matter how well they may be supplied with protecting devices.

Adjournment of the Senate Committee on General Laws.

The expected meeting of the Senate Committee on General Laws at the Hotel Metropole on the 3d inst. was not held. The Senators were in attendance, and were ready to go on with their investigation, but Chairman Erwin was absent. An extension has been granted to the committee of the time in which they have to tender their report to the Legislature to January, and it is understood that until the adjournment of the present session of the Legislature no more investigations will be held. During the summer months, however, the committee will continue their meetings in this city.

The Comparative Cost of Storage Batteries and Horses in Street-car Traction.*

BY PAUL GADOT.

PREFATORY NOTE.

The question of street-car traffic presents itself with more and more urgency to the municipal officers of large cities and to the different companies that operate different systems in different localities. We shall take it for granted that only upon street railways can storage battery traction, at the present time, advantageously be used. Our study, although mainly devoted to the system of tramways in Paris, will, we believe, furnish a basis for the investigation of the problems arising in other cities and a method for the discussion of each case.

An examination of the calculations and reasonings that we shall put forth will show that in Paris the storage battery system might advantageously be adopted. It is a matter of course that by this we do not mean to imply that our solution will suit all other cases; every system needs special study, upon which to found a wise choice of the means of propulsion to be adopted, as suited to the local conditions obtaining and to the desired degree of economy. We shall be pleased if our work shall assist the studies of others in their special problems.

Our thanks are due to the *Administrateurs de la Compagnie generale des Omnibus de Paris*, and especially to M. Marsillon, for their courtesy in placing at our disposal the remarkably valuable and well arranged documents of their bureau of statistics.

PRELIMINARY.

Our investigation, as we have said, will be of the Paris system; but it will be easy to adapt our conclusions to other systems, the standpoint being modified according to circumstances.

The statistics prepared by the General Omnibus Company, of Paris, which runs almost all the lines of street railways, show that a street car has made, during the past six years, the following average daily mileage;

In 1883	94.206	kilometers.
1884	94.507	"
1885	90.694	"
1886	90.7 3	"
1887	92.257	"
1888	93.376	"
Average	92.624	"

(A) For the purposes of the following study, we shall suppose that the daily run of a car will average, in round numbers, 100 kilometers, a figure quite justified by the increased mileage sure to result from the adoption of the accumulator system.

(B) These 100 kilometers will be supposed to take place over the ordinary street track, and in the condition in which it is usually found; and the average motive force will be considered as 10 kilograms per ton moved. This figure represents the average force expended, in curves or on the straight, up hill or down, and, in short, taking all the usual circumstances into consideration.

(C) We shall adopt, as a basis of investigation, a car of the usual Parisian pattern of 50 seats, with the following weights:

Weight of empty car	3,360	kilograms.
Weight of 50 passengers and 2 employés, at 70 kilograms each	3,640	"
Total, omitting all mechanism	7,000	"

(D) We shall adopt the following coefficients of power:

1. The steam engine used to charge the accumulators develops	100	kilogrammeters.
2. The charging dynamo will render 80 per cent. of this	80	"
3. The accumulators will turn out, considering the bad conditions under which they act, only 50 per cent. of the foregoing, say	40	"
4. The motors will render 75 per cent. of this	30	"
5. And, finally, the gearing will give 83.333 per cent. of this last, so that the driving wheels will develop	25	"

(E) We have seen (B) that the motive force per ton moved is 10 kilograms; per ton kilometer the average force will therefore be 10,000 kilogrammeters; combining this figure with table (D), we have the following:

1. On the drivers there will be a force of		10,000	kilogrammeters.
2. The motors will develop	$\frac{10,000 \times 30}{25}$	12,000	"
3. The accumulators will furnish	$\frac{12,000 \times 40}{30}$	16,000	"
4. The charging dynamo furnishes	$\frac{16,000 \times 80}{40}$	32,000	"
5. Finally, the engine used to charge the batteries will furnish	$\frac{32,000 \times 100}{80}$	40,000	"

(F) We shall suppose that the accumulators have an effective electric capacity of 7 ampère-hours per kilogram of the plates, and that the average rate of discharge, somewhat lessened by the occasional violence of movement, is 1.80 volts. Each kilogram of the plates could accordingly develop a total energy of $\frac{7 \times 1.80 \times 3,600}{9.81} = 4,624$ kilogrammeters. Therefore for moving a ton a distance of one kilometer there will be needed (see E 3):

$$\frac{1,600}{4,624} = 3.460 \text{ kilos. of the plates.}$$

For convenience we adopt 3.5 kilograms of the plates, which corresponds to 6.92 ampère hours instead of 7, and we shall concede that this involves a gross weight, in batteries, of 5 kilograms. But each kilogram of the plates will accordingly need to furnish but $\frac{1,600}{3.5} = 4,570$ kilogrammeters in round numbers, and in charging will require from the motor only $\frac{4,570 \times 100}{40} = 11,425$ kilogrammeters. These figures apply to batteries of lead, lead oxides, lead alloys, etc.; our work was based upon these because they are in fact most employed, but may just as well apply to others that fulfil the same conditions of price, durability, maintenance, effective capacity for weight etc.

(G) We assume a railway using twenty cars (a moderate service), plus five cars in reserve, which is more than practically necessary.

For the problem of storage battery traction, two solutions have been suggested:

1. The cars to contain the batteries, the receiving dynamos, and all the necessary mechanism, and therefore called automobile electric cars.
2. An electric locomotive to draw the cars.
3. We propose a plan of our own, in which the accumulators are carried on a separate truck, only the dynamo and drivers being on the passenger cars.

Having thus established the preliminaries of the problem, we shall successively examine these three solutions.

I. ELECTRIC MOTOR CAR.

This system requires certain somewhat costly alterations in existing cars, in order to place the mechanism, receivers, etc., so as to be accessible and easily removable, and especially so as to have the batteries in position to be removed, coupled, examined, etc., without difficulty; either in the interior of the car, which seems clumsy and would involve considerable deterioration; or, as seems most suitable, by placing the batteries in such way as to be easily accessible from the exterior, under the seats of the car. These modifications of the cars now in use are evidently, in the beginning at least, a real objection to the system; but we mention it only, in passing, to point out that if the substitution of electricity for horses takes place it will, of course, be done gradually, and the economical course will be simply to cease building the old cars and to replace them, as they wear out, with the new. If, furthermore, it is desired to hasten the change, will not this be a proof that the system is so advantageous as to make this additional expense actually economical? It seems evident that the cost of adapting an old system to a new should not prevent the consideration of the new, if this is in itself desirable; but should merely be considered in comparing with each other several new solutions of the problem. If the new system is the only possibility of progress, the fact that the old plant does not fit its needs is only a matter of course.

Let us see, in the first place, what weight of batteries would be needed for the motor car.

From (F) we find that for a ton kilometer there is required 3.5 kilograms of the plates, say 5 kilograms of gross weight of battery. Since this must be part of the weight moved, the general formula for finding the weight of batteries necessary to move a given weight for a given distance is:

$$(P + x)\, L \times 0.005 = x. \qquad \text{(H)}$$

In this equation P is the weight of the car (and all its passengers, mechanism, etc., save only the batteries) in kilograms. L is the distance. 0.005 is the weight in kilograms of the batteries necessary to move one kilogram one kilometer. (See F.) x is the weight in kilograms of the batteries.

In order to ascertain how the batteries may do their work most economically, we shall suppose that the daily service of each car is accomplished:

1. By a single group of accumulators capable of doing 100 kilometers per day.

2. By two such groups, each doing 50 kilometers, the second replacing the first about noon.

3. By three groups, each doing 33 kilometers; and so on.

FIRST. *Traction of a motor car with a single group of batteries per day.*—We have seen (C) that a loaded car ordinarily weighs 7,000 kilograms; the weight of the receiving dynamo and mechanism should be about 500; total, 7,500 kilograms.

This is the weight represented by P in (H); so that we have $(7,500 + x)\, 100 \times 0.005 = x$, whence $x = 7,500$ kilograms.

This enormous weight plainly shows that to propel a car all day with the one set of accumulators would be absurd.

SECOND. *Traction of a motor car with two groups of batteries per day; each for, say, 50 kilometers.*—Here we have $(7,500 + x)\ 50 \times 0.005 = x$, whence, as before, $x = 2,500$ kilograms, which represents the gross weight of each group of batteries.

THIRD. *Traction of a motor car with three groups of batteries per day, each for, say, 33.33 kilometers.*—We have, as before $(7,500 + x)\ 33.33 \times 0.005 = x$, whence $x = 1,500$ kilograms, weight of each of the three groups of batteries. Similarly we may continue with four groups, each for 23 kilometers: $x = 1,071$ kilograms; with five groups, $x = 835$ kilograms; with seven groups, $x = 577$; and with ten groups, $x = 395$.

It must be remembered, of course, that in practice the exchange of the newly charged battery for the exhausted one could only be effected at the end of the route, and not exactly at the distances mentioned above; each particular line must adjust its arrangements in this respect to its own circumstances.

Each exchange involves the shunting of the car into the station, generally placed close to the terminus; the removal of one set of batteries and the insertion of the other, their connection, etc., and the return of the car to the terminus. All this should consume not over twenty minutes, and should not involve, if properly arranged, a serious increase in the number of cars used over the number made necessary by similar changes in horses under the present system.

Now, let us examine the different hypotheses above given:

Number of groups of batteries per day per car.	Distance traversed by each group in kilometres.	Gross weight of each group in kilograms.	Net weight of the plates of each group in kilograms.
1	100	7,500	5,250
2	50	2,500	1,750
3	33.33	1,500	1,050
4	25	1,071	750
5	20	833	583
7	14 286	577	404
10	10	395	277

FIRST. *With one group.*—We have seen that the enormous weight of the accumulators renders this hypothesis impracticable.

SECOND. *With two groups, each driving the car 50 kilometers.*—

Number of cars for service, 20; in reserve, 5; total, 25.

Weight of batteries.—Each car requires a gross weight of 2,500 kilograms per group, or 5,000 for both groups, that is to say for the day's work; and for 20 cars, 100,000 kilograms; batteries in reserve, say 15 per cent., 15,000 kilograms; total gross weight, 115,000 kilograms; also a weight in the plates of $1,750 \times 2 = 3,500$ kilograms. For 20 cars, 70,000 kilograms; in reserve, 15 per cent., 10,500 kilograms; total weight of plates, 80,500 kilograms.

Charging the Batteries.—From (F) we find that each kilogram of the plates requires, in charging, a force of 11,425 kilogrammeters; therefore for 70,000 kilograms of plates there will be needed per day $11,425 \times 70,000 = 799,750,000$ kilogranmeters. Say $\frac{799,750,000}{75 \times 3,600} = 2,962$ h. p. hours, or about 200 h. p. during 15 hours.

These last figures will enable us to ascertain the cost per kilometer of running each car; this cost will include:

a. Salaries in the station, less those stated elsewhere under cost of motive power.
b. Salaries of car-drivers.
c. Motive force for charging the accumulators.
d. Interest on capital invested in batteries.
e. Repairs to accumulators, renewal of boxes, insulators, acids, etc.; labor of changing plates.
f. Loss through batteries rendered useless.
g. Interest on capital invested in motors and mechanism of cars.
h. Repairs to same.
i. Deterioration in same.
j. Oil, waste, etc., used on the dynamos and machinery.
k. Maintenance and repairs to tools in depot and on cars.
l. Interest, deterioration and repairs of the charging dynamos, transmitters, belts, etc., at depot.
m. Unforeseen and various expenditures.
n. *Deduct* receipts from sale of old batteries.

We shall take the most unfavorable case of a depot furnishing but one line, and shall estimate all expenses for one year.

a. Salaries of the station staff.—Chief, 4,800 francs; electrician-in-chief, 3,600 francs; six electricians, 16,200 francs; eight laborers, 14,400 francs; three others to charge batteries, 3,600 francs; total, 42,600 francs.

b. Twenty-one car-drivers, of which one is for emergencies, 63,000 francs.

c. Motive power.—There are 2,962 horse power hours per day, which we shall estimate at 0.085 francs each, this liberally covering interest, wear and tear to motors and boilers, salaries and all repairs, maintenance, oil, etc. Per day, $2,962 \times 0.085 = 251.77$ francs; per annum, $251.77 \times 365 = 91,896.05$ francs.

d. Interest on battery capital.—We have 80,500 kilograms of plates, at a cost, including construction, boxes, insulators, acids, etc., of 1.25 francs per kilogram, $80,500 \times 1.25 = 100,625$ francs; interest at 6 per cent. = 6,037.50 francs.

e. Repairs to accumulators, boxes, insulators, acids, etc., and change of plates may be put at 0.30 francs per annum per kilogram of plates.

$$80,500 \times 0.30 = 24,150 \text{ francs.}$$

f. Loss of plates.—The plates alone cost 0.85 francs per kilogram $= 70,000 \times 0.85 = 59,500$ francs. They must be renewed, considering the very hard usage they undergo, say twice a year; the negative plates are destroyed much less rapidly than the positive. There will be thus an expense of

$$59,500 \times 2 = 119,000 \text{ francs.}$$

From which must be deducted the price of the old plates, say at 0.20 francs per kilogram: $70,000 \times 2 \times 0.20 = 28,000$ "

Leaving an annual expense of..... 91,000 "

g. Interest on capital; motors, machinery in cars, etc.—For transforming each car, purchasing dynamo and machinery, etc., may be allowed 3,000 francs or $25 \times 3,000 = 75,000$; at 6 per cent. = 4,500 francs.

h. Repairs to same.—At 500 francs per car may be estimated at 12,500 francs per annum.

i. Deterioration of same may be taken at 20 per cent., owing to the special conditions under which they are placed. We have then 75,000 francs (see *g*) $\times 0.20 = 15,000$ francs.

j. Oil, waste, small details, etc., on dynamos and cars may be placed at 2.50 francs per day per car in service.

$$2.50 \times 20 \times 365 = 18,250 \text{ francs.}$$

k. Maintenance and repairs of tools may be placed at 6,000 francs per annum.

l. Interest, deterioration and repairs of the charging dynamos, transmitters, belts, etc.—Taking the capital at 32,000 francs, and allowing 25 per cent. to cover all, we have an annual charge of 8,000 francs.

m. Various charges. 10,000 francs.

Recapitulation for a line of 20 cars of 50 seats each, using motor cars and two groups of batteries for running each 50 kilometers per day; annual expenses:

	Francs.
a. Salaries at station	42,600
b. Drivers	63,000
c. Motive power	91,896.05
d. Interest (batteries)	6,037.50
e. Repairs to batteries	24,150
f. Deterioration in plates	91,000
g. Interest, motors and machinery in cars	4,500
h. Repairs " " " " " "	12,500
i. Abatement, dynamos and machinery in cars	15,000
j. Oils, waste, " " " " " "	18,250
k. Maintenance and renewal of tools in the depot and on cars	6,000
l. Interest, deterioration, repairs on dynamos, transmitters belts, etc	8,000
m. Various items	10,000
Total for traction	392,933.55

The annual number of kilometers traversed by all the cars of such a line being $(100 \times 20 \times 365 =)$ 730,000, the cost of traction per car per kilometer is 0.538 francs.

Before passing to the hypothesis of three groups of accumulators, we may state approximately the capital necessary for installing battery traction with two daily groups of storage batteries per car.

	Francs.
Engines and boilers, 200 h. p. at 750 francs	150,000
Dynamos for charging, transmitters, etc	32,000
Fitting up station, construction, etc	18.000
Storage batteries	100,625
Alteration of cars	75,000
Tools, etc	6,000
Extras	23,375
Total	405,000

Or $\frac{405,000}{20} = 20,250$ francs per car in service.

Continuing, now, our investigation of the other cases suggested, we may take the case

THIRD. *Three groups of accumulators per day, each for 33 kilometers.*

It will not be necessary here to repeat the long details given in the previous case; we shall merely alter the figures to suit the circumstances, recalling the main lines of our arguments.

Number of cars.—25.

Weight of accumulators.—Our table gives 1,500 kilograms for each group; for the three, 4,500 kilograms.

And for 20 cars in service	90,000 kilograms
Counting 15 per cent. in reserve	13,500 "
From which, total gross weight of accumulators	103,500 "

*From *La Lumiere Electrique.*

Corresponding to a weight of the plates per car of 1,050 ×3=3,150 kilograms.

And for 20 cars	63,000	kilograms
Reserve 15 per cent	9,450	"
Total weight of plates	72,450	"

Charging the batteries.—The charging of each kilogram of the plates requiring (see F) a force of 11,425 kilogrammeters for charging 63,000 kilograms of the plates in service, there will be needed daily 63,000 × 11,425 = 719,775,000 kilogrammeters; or $\frac{719,775,000}{75 \times 3,600} = 2,666$ h. p. hours, or say 157 h. p. for 17 hours daily, from which may be gathered the cost of the 13 items, making up the cost of pure traction as in the former case.

a. Salaries in station, less those charged to motive force. Since in this case we have 10 per cent. less plates to care for, charge, etc., but also more changes in plates to be made than in the case of two groups of batteries, these items about balancing each other, we may leave this figure as it was before, *i. e.*, 42,600 francs.

b. Car-drivers.—As in the other case, 63,000 francs.

c. Motive power used in charging: Per day, 2,666 h. p. hours at 0.085 fr. = 266.61 fr. Per annum, 226.61 × 365 = 82,712.65 fr.

d. Interest on storage battery capital: 72,450 kilograms of plates at 1.25 fr., including boxes, etc., represent a capital of 90,562.50 fr., and an annual interest charge of 5,433.75 fr.

e. Repairs to batteries, boxes, etc., change of plates, etc., 72,450 kilograms at 0.30 fr. = 21,735 fr.

f. Deterioration of plates:

The plates in service cost	63,000 × 0.85 fr. =	53,550 fr.
With an average renewal twice a year	53,550 × 2 =	107,100 fr.
Deduct price of plates disused	63,000 × 2 × 0.20	25,200 fr.
Leaving annual cost		81,900 fr.

g. Interest charge on motors and machinery in cars, as before, 4,500 fr.

h. Repairs to same, as before, 12,500 fr.

i. Deterioration of same, as before, 15,000 fr.

j. Oil, waste, details in cars, as before, 18,250 fr.

k. Tools, as before, 6,000 fr.

l. Interest and deterioration in the charging dynamos, transmitters, belting, etc., in the depot: There will be about 126 electric h. p. at 200 frs. per h. p.=25,200 frs.=at 25 per cent. for interest, deterioration, repairs, etc., 6,300 frs.

m. Various charges, 10,000 frs.

Recapitulation of annual expense for pure traction with three groups of batteries per car per day:

	Francs.
a. Salaries in station	42,600.00
b. Car-drivers	63,000.00
c. Motive power for charging	82,712.00
d. Interest on capital in batteries	5,433.75
e. Repairs to batteries	21,735.00
f. Deterioration of plates	81,900.00
g. Interest on car, motors and machinery	4,500.00
h. Repairs " " "	12,500.00
i. Deterioration " " "	15,000.00
j. Oil, waste, etc., on cars	18,250.00
k. Maintenance, etc., of tools, etc	6,000.00
l. Interest, deterioration, repairs, to charging dynamos, transmitters, belts, etc	6,300.00
m. Various	10,000.00
Total	369,931.75

The total distance traversed by all the cars being 100 × 20 × 365 = 730,000 kilometers, the price per car per kilometer comes to 0.507 francs. Comparing this with the cost of the system of two sets of batteries per day we have a difference of about six per cent. in favor of the system now discussed of three changes per day.

As in the previous case we may now approximate the capital needed to introduce this system:

	Francs.
Engines and boilers, 157 h. p., at 750 francs	117,750
Dynamos for charging, transmitters, etc	25,200
Fitting up station, construction, etc	18,000
Storage batteries	90,562.50
Alteration of cars	75,000
Tools, etc	6,000
Extras	21,487.50
Total	354,000.00

(To be Continued.)

Single and Double Trolley Wire Systems for Electric Railways.

The following is the paper on this subject read before the Boston Electric Club by Mr. George W. Mansfield, engineer of the railway department of the Thomson-Houston Electric Company:

In addressing you this evening on the subject of "Single and Double Trolley Wire Systems for Electric Railways" I shall endeavor to place precisely before you the advantages and disadvantages of each system. The other day while studying over the subject the following questions arose in my mind: Why should I spend any time whatever in discussing the two systems? Is it necessary? If so, why? I think my telephone friends here could answer that question perhaps.

I read Mr. Denver's paper with mingled pain and pleasure—pain on account of his sufferings, and yet pleased to learn, clear at the end of the paper, that he had a remedy. The antagonism of the telephone companies to the single wire system has become universal and their love for the double wire system proverbial. This opposition has provoked much discussion and led to deep thought. My own thinking and experience has forced me to the solid conviction that for an efficient electric railway system that can universally be used, the single trolley wire is the only one to be considered. Being, then, of this conviction, the time I spend upon the double trolley wire system is purely educational for my dear friends in the telephone companies, and I trust I merit their hearty applause since they all tell me they want electric railways and the best.

The principles involved in the construction of a single trolley wire system are familiar to you all. You know that it can be done successfully and is done successfully. Do you or does any one know that under all the conditions under which the single trolley wire works successfully the double trolley system will also work successfully?

If the difficulties with the single system have all been overcome and those of the double system have not, let us consider what we must take into account to make the latter equal the former.

With the double system the weight of the second wire, the insulators, frogs, crossovers, etc., the double liability of sleet and ice accumulating on the two wires, and the high winds all necessitate larger and stronger poles and stronger span, pull-off and anchor wires, etc. This increase in size and number of wires means additional unsightliness, a larger original outlay and an increased expense for maintenance.

One of the chief troubles that an electric railway has to contend with is to keep its trolley wire free from snow and ice during the winter months. Prompt and energetic action, with a greased trolley wire has saved the single trolley roads from any serious delay. If these same roads had had two wires to clean, I have no question but that their service would have been seriously impaired, if not entirely stopped.

I do not think that the question of traction is one of any serious moment. The rails must be cleaned for adhesion and for the cars to keep on the track irrespective of whether the single or double trolley wire system is used, and as they are get-at-able they are comparatively easily taken care of. It is simply a question of management, muscle and salt, and with improved electric sweepers and plows, there never need be any great difficulty in keeping the cars running on schedule time. The problem, however, of cleaning sleet frozen to a trolley wire placed 18 feet above ground in a large city or even on a country road is a most annoying and troublesome one.

One, if not the greatest, difficulty which would have to be overcome with the double trolley system is the liability to leakage. The two wires hanging side by side upon the same span wire need the best of insulators. Considering all the atmospheric conditions and the possible accumulations of sleet and snow, it unquestionably would be more difficult to maintain good insulation between the two wires than it is between the single wires and the ground. With the latter system you have far greater opportunities to introduce additional insulation. It can be cut into the span wire or placed on the pole, whether it be of iron or wood.

So far the under-running double wire roads have had the wires placed either six inches or eighteen inches apart. The Daft roads employ the former distance, while the Thomson Houston Company in its attempt at Cincinnati used the latter distance. Both methods have their objections. If the wires were placed too near, strong winds may swing them together, causing short circuits. In one place the short circuits was so heavy that the wires were melted and fell into the street. With the wires farther apart plainly this trouble would not exist. With the wires close together a single trolley arm can be used, but a double trolley fork and two wheels are necessary. These wheels must be thoroughly insulated whether they rotate upon a separate or upon the same spindle. The maintenance of an insulation sufficient to withstand 500 volts under such conditions is surely not an easy task.

With the wires further apart the necessity of more than one frog at the crossings and turnouts is necessary, which is objectionable, and more than one trolley arm would have to be used. The maintenance of these trolley arms, the difficulty of keeping them on the wires, and their weight upon the roof of the cars are all serious objections. In the single wire system questions of weight, insulation of trolley wheels, etc., practically do not enter.

Another serious objection to the double system is the overhead switching. The placing of overhead frogs even on the single wire system requires the greatest exactitude and care, so much so that on many roads it has been found necessary to train a special gang of men to place and look after their adjustment. The expansion and contraction of the wires and the giving and taking of the poles are constant sources of annoyance and trouble in keeping the frogs and insulators in place. The expansion of copper is $\frac{1}{4}$ inch per degree for 1,000 feet, or $\frac{1}{8}$ of an inch per mile for each degree of change in temperature. If the temperature changes, as it often does, twenty or thirty degrees in a day, the trolley wire might expand or contract fifteen or twenty inches per mile. With the double trolley wire system the location and maintenance of the frogs on the crossovers and turn-outs would, in view of these circumstances, be an extremely difficult one. They would require constant adjustment and readjustment, and if the method of placing the trolley wires 18 inches or more apart was employed, so that a large number of frogs was introduced, it would practically be a determining factor between the possible and the impossible system.

On complicated systems of double track lines, the number of insulators and frogs for the double wire system would be very large. I have frequently studied such systems and have found that it is by no means a rare occurrence to meet arrangements of tracks that require from 25 to 50 overhead frogs and insulators, and in some instances from 125 to 150. The weight of all these necessarily demands a most substantial overhead construction, and undoubtedly the only thing that could be done would be to erect large and substantial trusses. It must be also evident that the difficulty of keeping the trolley wheel upon these wires is largely increased, and also the liability of some of the ends breaking loose from a frog and falling.

Imagine such a network of wires loaded with ice on a winter's morning. Add to these wires, if you will, the necessary guard wires, and it is as essential to put up guard wires, with the double system as for the single, and I, for one, would not have sufficient audacity to argue for the same before a city council. It can also clearly be shown that the wires of the same polarity of the double system will not in all conditions correspond when they are attached to the frog. To illustrate what I mean, take the single track Y. If a sketch of this is made on the double wire system, it will be seen that if the right hand wire is a positive wire and the left hand wire a negative wire on a straight piece of track, and they are carried around the Y on to a branching track, the positive and negative leads are bound to conflict. Under such circumstances either the current must be broken on the motor when the car passes that point, or there will be bad flashing in the switch.

It is practically impossible to construct a frog for such a place that will permit the trolley wheels to roll across, taking current from the same continuously. There will have to be a break in the continuity of the circuit at the frog for a certain length of time. This break means the going out of the lights every time the car passes such a frog. With the single wire system, none of these difficulties are experienced. On large roads the cost of copper necessary for the double wire system would be so great as to be almost prohibitory. With the single trolley system, the earth being used as a return circuit, we obtain the aid of its conductivity and also that of the rails. Practice has demonstrated that with such an enormous conductive area the resistance of the return circuit can practically be considered *nil*. It is true that the supplementary wire of a size equal to the trolley wire is run through the earth and connected to each rail. The use of this conductor is twofold. It not only forms a good ground for each rail but it ties the whole underground system into one connected and complete metallic system. Counting the resistance of the earth as O, it is readily seen that only one-quarter of the copper wire is necessary for the single system as for the double wire system. Hence a most decided saving is possible.

On a large system the subject of feeders always is a most important one. With the single trolley system it is only necessary to feed one-half of the circuit, whereas with the double trolley system it is necessary to feed both sides of the circuit. In this direction alone, therefore, the cost of the latter system must be four times that of the former, allowing for the same percentage of loss.

In regard to guard wires, I see no reason why it is not practically as necessary to place them over a double wire system as over a single. With the current passing out over one wire down through the car, through the motors under the car and back by the other wire, the chances of leakage are very great.

It would be very difficult to prevent leakages somewhere on such circuit. If a leakage should be established on the positive side of a motor armature on one car and on the negative of another, both of the cars and the station might be damaged. If these leakages are so liable, the danger from a foreign wire falling across either one of the trolley wires still exists. It is unfortunate, but nevertheless true, that arc light wires that are supposed to be thoroughly insulated from the ground, leak at times sufficiently to cause damage to life and property if a telephone or telegraph wire happens to fall across them. With bare trolley wires and with the increased chances of leakage, surely the city authorities would not and ought not to permit the erection of the double trolley system without the same system of guard wires over them as is placed over the single trolley system. The expense incumbent upon the railway company in this direction therefore is equal for both systems. The danger to property in my opinion is practically equal in both systems.

I do not deny the fact that it is possible so to construct a simple double trolley system that a falling wire touching one of the trolley wires, and with its other end on the ground, would deflect no current, nor would I deny that under similar conditions a man touching this fallen wire and standing upon the ground would receive no shock. This is speculation, not fact, and I am not arguing this matter from a theoretical or possible condition of affairs, but from the results of practice which teach that ordinary existing circumstances always militate against the ideal, giving as a resultant a system materially different from what we supposed it would be.

Repeating, therefore, what I have said in regard to danger to life and property, I feel that the danger question is practically equal in both systems.

It is unnecessary for me to state to you the fact that 500 volts are not dangerous to life since I think that there is no question but what you all have taken such a potential, if not higher, and I should be pleased to have any of you state, if a discussion follows this paper, whether you have taken this potential or a higher one, and the circumstances.

As to the relative expenses of the two systems, leaving out the question of feeder wires, it is true that practically in every case the double trolley system would cost one-half as much more, if not twice as much, as the single trolley system. It may here be stated that the expense of running the supplementary wire underground is sometimes heavy. True, it is, but the expense is largely dependent upon the street through which your track passes. If it is macadamized or paved with Belgium blocks, or with any paving stones, the expense of the removal and replacement of the same would be large. Such conditions of streets, however, exist only in large cities, and here I believe it is generally conceded by friends and opponents that the double trolley system is entirely out of the question. The expense, however, would nowhere nearly equal the additional expense of the feeder wires for the double system, nor would it equal the cost of the maintenance of such a system for a year or two.

If, on the other hand, I admit that it is possible, but not the best system for a small road, we are happily confronted by the fact that so far, in the majority of the cases, the small roads are not where it is needed, since the telephone companies, which practically represent the only opposition to the introduction of the electric railway, have not so extensive lines in these places. It is, therefore, the unfortunate middle man that has to suffer. In answer to all the foregoing objections to the double trolley wire system, the statement is sometimes made that there are to-day double trolley roads operating and commercially successful; and that if they can operate in one place there is no reason why they cannot be made to operate in all other places. Steam dummies are used to-day in some places; why do not railroad companies use them everywhere? There is scarcely anything impossible in this practical age of ours, and therefore I do not deny that the double trolley system could be placed anywhere that the single is placed, but I unhesitatingly state and know that it could not be placed wherever the single is placed, and prove equally as satisfactory and commercially successful. It is not a question of cost but one of expediency and practicability. The electric companies would build double systems if they could guarantee them, and the railroad companies would demand them if they had confidence in them. An unbiased thinking man is forced to adopt the single system.

History shows that the efforts of the early promoters of the electric railway were to develop a double wire system with an over-running trolley. This has proved a signal failure. The only roads so operated to-day are at Easton, Pa., Elkhardt, Ind., Ithaca, N. Y., Lima, Ohio, Pittsburg, Pa., Sunbury, Pa., St. Catharines, Ont., Lancaster, Pa., Ashbury Park, N. S., Appleton, Wis., and Wheeling, W. Va., eleven in all. There are none under contract, and no firm thinks for a moment of building such a system. History also shows us that the next step in progression was the development of the under-running trolley for this same double trolley wire system. Years have gone by, and we have only three companies in the whole United States having such a system in operation; these are at Cincinnati, O., Meriden, Conn., and Mansfield, O. As illustrative of the feeling and confidence the street railway profession have in this system, I find there are but five companies who have contracted for such a system. I venture to assert at this point that if the conditions of the contracts for these roads were seen, most interesting and extraordinary clauses would be discovered.

If we now turn to the extraordinary development of the

single trolley system, we find figures which truly are amazing. On July 1, 1888, the Thomson-Houston Company was not in the electric railway business, and the total number of roads in operation in the United States and Canada, put in by all of the electric companies who were then doing business, viz., Sprague, Daft and Van Depoele, was 33. Of these, but two or three were the single-wire system under-running trolley; whereas to-day there are nearly 115 roads in operation, and an equal number under contract, and of these all but four or five have been put in or contracted for by either the Thomson-Houston Company or the Sprague Company. Two hundred and thirty roads contract for the single system, five for the double. If I take the history of the Thomson-Houston Company since it commenced to build electric railways, I will find that it has in less than two years put 61 roads in operation, and has under contract 45 more, making a grand total of 106 roads contracted for with the single trolley system, by one company. Could there be more conclusive proof of the pre-eminent adaptability to a commercial necessity than this is for the single trolley system?

The future is destined to surpass this record as surely and as amazingly as the adoption of electric lights and telephones surpassed their records of eight or ten years ago.

After the reading of the paper a discussion upon the points raised took place, Mr. W. J. Denver, Mr. Dumoulin, Mr. F. M. Gilley, Mr. Alex. P. Wright taking part. There was a consensus of opinion, however, among those present, so the discussion was very brief.

Death of D. L. Gibbens.

Ex-Subway Commissioner D. L. Gibbens died after a brief illness on the night of Friday, May 2. He was well known in electrical circles, and his untimely decease is regretted by many warm friends.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, May 5, 1890.

The New American Electric Light Company have removed to No. 2 Courtlandt street, where they will be glad to meet their friends.

Hanson Van Winkle has moved from 92 to 81 Liberty street, where he will take pleasure in continuing to serve customers with dynamos and outfits for electric plating.

William Grunow, Jr., expert electrician and mechanician, 204 and 206 East Forty-third street, is prepared to undertake work on the most difficult pieces of machinery, models, etc.

The United Electric Traction Company, 115 Broadway, have made their first installation under the new name. It is the Danbury & Northumberland Railway, and runs between the two towns of the same names in Pennsylvania.

The American Electrical Works, principal offices and works at Providence, R. I., have removed their New York office to 10 Courtlandt street, this city. Mr. P. C. Ackerman, their agent, says he is now ready to receive and discharge all orders for Faraday cables, and insulated wires and cables generally.

The Electric Alarm Clock, a cut of which may be seen in our advertising columns, is meeting with a large demand. The Manhattan Electrical Supply Company, 26 Church street, say that their supply trade for these clocks is in excellent condition, and orders are rapidly increasing in number and size.

Einhigler & Adler, manufacturing electricians, have removed to their new factory, Nos. 244, 246 and 248 West Twenty-seventh street, between Seventh and Eighth avenues. They are now ready to fill all orders with the same satisfaction to their customers that has characterized their transactions in the past.

The United Electric Light and Power Company, *Times* Building, has decided to increase its capital stock from $3,000,000 to $5,000,000. New stocks preferred and entitled to a preference not exceeding 6 per cent. out of the first earnings of the company before any dividends are paid on the common stock. Purpose, improvements and enlargement of business.

The Crocker-Wheeler Electric Motor Company have removed to the building bounded by Washington, 13th and 14th streets, this city. Heretofore this company have been compelled to ask indulgence in filling their orders, but now with their increased facilities they hope to handle all business promptly. They will be glad to answer any inquiries pertaining to electrical engineering subjects.

Young's Automatic Safety Cut-Out, the exclusive control of which is held by the Royal Electrical Specialty Company, 239 Water street, is having a steady sale throughout the country. The cut-out is for use on all high-tension electric circuits, operates automatically, and renders the wire dead instantly on the breaking of the circuit. The device is simple and compact and cannot get out of order.

The Field Engineering Company, 15 Cortlandt street, have contracted with the Detroit Electric Light and Power Company for all their underground conduits. More than 40 miles of the new ducts of the Interior Conduit Company's system will be used. These tubes are themselves insulators, and thus permit the laying of bare or water-proof wires within them. The Field Company make a specialty of these conduits.

The Rice & Whitacre Manufacturing Company, 47 and 49 South Canal street, Chicago, have just shipped several of their new pattern of small double cylinder steam engines, designed especially to drive small dynamos generating current for light or motive power. Wherever this type of engine has been given a thorough test the reports have been satisfactory in every respect, showing that the engine is specially adapted for the work for which it was intended.

The New Factory of C. C. Sibley & Co., designers and manufacturers of electrical appliances, has just been established at 416-418 West Twenty-sixth street, and is completely equipped with the most improved machinery. Mr. Sibley has had several years' experience in manufacturing and designing electrical specialties, and, ably seconded by Mr. J. H. Jahn, is prepared to manufacture electric light, railway, telegraph, fire alarm and telephone supplies—in fact everything, from the ordinary push button to the finest apparatus. They make a specialty of manufacturing goods in large quantities for the wholesale trade.

The Fishkill Landing Machine Company, Fishkill-on-the-Hudson, N. Y., builders of the Fishkill-Corliss engine, find business exceedingly brisk. We are informed that they have just completed, ready for erection, a vertical condensing engine of 1,000 h. p., for the new grain elevator of the New York Central & Hudson River Railroad Company, at the foot of Sixtieth street, N. R, New York city, and have also recently received an order for a similar engine of 800 h. p., for an elevator to be built for the West Shore Railroad, at Weehawken, N. J. These engines will be fitted with the Fishkill-Corliss valve-gear. The engines built by this company are usually of the horizontal type, but, owing to the limited space in grain elevators, they are sometimes made vertical.

The Double Valve Straight-line Engine, which received the gold medal at Paris last fall for the best automatic high-speed engine, is meeting with large sales through the general agents, Williams & Potter, 15 Cortlandt street. The engine is especially adapted for large isolated electric light plants in buildings where they utilize the exhaust steam for heating purposes. This plan has been adopted and successfully operated in the Astor building, the Mutual Life Insurance building, the Museum of Natural History, and a number of other buildings in this city. Nine of these engines are being used in the great auditorium in Chicago, where they heat the building with the exhaust steam. Messrs. Williams & Potter are also installing this engine with condensers, pumps, etc., in the new ferry boat Texas, of the New York & Brooklyn Ferry Company.

The Edison Illuminating Company have, through their agent, Mr. H. A. McLean, 432 Fifth avenue, closed some very promising contracts for isolated and central station lighting, among which are the following: 600 lights for the Central Club, New York City; 800 for the German Club, New York City—both clubs to be furnished with power from the Thirty-ninth street station; 550 lamps for the Jordan L. Mott Iron Works, with power from E. P. Hampson & Co.'s Eclipse Corliss engine; two 400-light Edison dynamos in James Everard's brewery; 300 additional lamps in the Central Turn Verein; two 400-light machines in the Mechanics' National Bank, power from two new double-valve, Straight-line engines; and two No. 20 800-light Edison machines in the American Biblical Society's building, run from two 150 h. p. new double-valve Straight-line engines.

Mr. Chas. D. P. Gibson has accepted the presidency of the Gibson Electric Company. Mr. Gibson successfully conducted the business of the firm handling the Gibson battery, before it was formed into the present stock company. In consequence of the increased facilities for manufacture, as well as the result of recent experimenting, the company now say they are able to sell the Gibson storage battery at a reduction of 50 per cent. on the former price. Some large contracts for the batteries have recently been closed, among which is that for entirely fitting up Mr. F. H. Lovejoy's steam yacht Neaira, now lying in Erie Basin, into which they will put 40 cells; the steam yacht Baltimore, owned by Gen. Brown, of Baltimore, is being overhauled, the set of Gibson's batteries on her were found in good order; also adding 66 cells to the original plant of 198 cells in Aldrich Court, 45 Broadway, this city. The company mean to spare no effort towards making their already excellent battery the best in the market.

The New Electric Light Shield that has recently been put on the market by the A. A. McCreary Electrical Specialty Company, 18 Cortlandt street, is made of insulating and fireproof material, and is used for incandescent shades and reflectors. It is especially adaptable for arc lamp shades where there are openings either at top or bottom, and performs efficient work in keeping the lamps clear of insects, dust, rain, sleet and snow. The above company are continually adding to their line of specialties. Their small incandescent bulb half shades are manufactured in all colors, and are for 16 and 32 c. p. lamps. Their reflectors of standard design are being called for all over the country, orders for 100 dozen having been received in a single day not long ago; 20,000 are now in use in this and other countries. The half shade, which they make in various colors, though but lately put on the market, has already been ordered to the amount of 6,000 for libraries, galleries, art schools, theatres, etc. Other valuable electrical specialties are controlled by this company, and will receive due notice in these columns. Mr. A. A. McCreary some years ago originated these reflector shades, and at the time prophesied the immense success that they have attained. To increase the facilities for manufacturing, Mr. McCreary, who had previously carried on the business himself, lately formed the above stock company, and the old business is now conducted under the name of the company at the head of this note and managed by Mr. McCreary.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, May 5, 1890.

The Emerson Power Scale Company, of Boston, has moved into its new office, Room 2, No. 12 Post Office Square.

The Gloucester (Mass.) Electric Light Company have placed their poles as far as the Reed & Gammage establishment at East Gloucester.

The Electric Gas Light Company, Boston, has taken the agency for New England for the Mason primary battery, which is attracting so much attention.

The New Haven (Conn.) Clock Company has been absorbed by the National Electrical Manufacturing Company which has recently been formed by a syndicate of New York capitalists.

West Lynn, Mass.—The Thomson-Houston Electric Company has purchased the Newhall property adjoining the Otis lots, which it recently secured. This will enable the company to make the three-story addition to Factory C about 40 feet longer than was contemplated in the original plan.

The Wainwright Company, Boston, report the following installations: Blue Hills Electric Light Company, Canton, Mass., one 200 h. p. compound engine heater. Rutland (Vt.) Electric Light Company, one 300 h. p. compound engine heater. Portsmouth Gas and Electric Company, one 300 h. p. compound engine heater. Wilmington (Del.) City Electric Railway, one 300 h. p. improved feed-water heater.

Prof. Thomson, of the Thomson-Houston Company at Lynn, Mass., has just moved into his new mansion on Burrill street, Swampscott. An interesting feature of the premises is his laboratory, which is located on the second floor of the stable, and connected with his house by a very artistic bridge. Some novel electrical features have been introduced in the construction of both house and stable.

A Public-Spirited Citizen.—A citizen of Montello, Mass., evidently appreciates the value of electric railways, for he has offered to invest $25,000, with three like investors, for the purpose of erecting an electric street railway in that place. It is proposed that the road run north to Howard street from the south end of Montello street, beginning at Campello, thence up Oak street, to Warren avenue, and south again to Campello, thus making a belt road.

North Abington, Mass.—The citizens are anxiously awaiting the decision of the gas commissioners upon the matter of the electric light franchise, which was originally granted to John F. Simmons, H. H. Pratt and two others. The Westinghouse Electric Light Company, it is asserted, claims to hold an assignment of this franchise, but as yet have not filed it with the commissioners, although three hearings have been held. Work will be begun as soon as a decision is rendered by the commissioners as to who holds the franchise.

The Board of Aldermen at their last regular session amended the standing regulations of the board relating to the speed of cars so as to read thus: "The rates of speed allowed to horse or electric cars in the city of Boston shall be as follows: North of Charles and Pleasant streets and Broadway Extension and the east side of Fort Point Tunnel and including said streets, seven miles per hour. South or west of the above streets and north or east of Chester Park and Swett streets and including said streets, and Beacon street from West Chester Park to the Boston & Albany Railroad Bridge on said street, ten miles an hour; outside of said limits, twelve miles an hour.

The Tripp Manufacturing Company, of Boston, are at present engaged in building a double truck car for the West End Street Railway, of Boston. The car will have eight wheels, will be 28 feet long from door to door, 7 feet 3 inches wide, 7 feet 9 inches in height from the floor and will have a seating capacity for 40 passengers. Each truck has four 30-inch steel wheels and two 15 h. p. Thomson-Houston motors. The car will be provided with vacuum and hand brakes, and the brakes will be operated by a toggle joint arrangement, giving immense power. The Tripp patent roller bearings will be used throughout, and the car will be hung on trucks of an entirely new design (on which patents are pending), the equalizing bar being connected direct to the journal boxes underneath instead of passing around on top as hitherto.

L. H. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, Chicago, May 5, 1890.

Seattle, Wash.—$400,000 worth of the electric railway company's bonds was recently sold in the East by L. H. Griffith.

The Cincinnati Electric Light Company's stock is active and in demand. Five hundred shares were sold May 1 at $1.80.

The Mansfield (O.) Electric Street Railroad Company has been purchased by the Daft Electric Company, and improved service is promised.

Mr. William A. Stiles, formerly with the Van Depoele Electric Manufacturing Company, has opened a law office in room 1,028, Opera House building, Chicago.

Mr. J. J. Creaghead, formerly with the Westinghouse Electric Company, has been placed in charge of the electrical department of the home office of the Fraser & Chalmers Company, Chicago.

Mr. Charles Wilson, the northwestern representative of the Babcock & Wilcox Company, with headquarters in the Corn Exchange building, Minneapolis, was a welcome visitor in Chicago last week.

The Big Sandy Packet Company, of Cincinnati, have installed a 16-light arc plant of the Fort Wayne Jenney system, using it in lighting their wharf-boat, and the river front between Sycamore street and Broadway.

Vincennes, Ind., will be lighted by electricity. 200 incandescent lights will be supplied for $6,000 per year. If additional lights are ordered, either by the city or by private parties, they are to be paid for at the same rate. The contract is for ten years.

The Cincinnati Electric Light Company are setting up an Edison 2,500-light dynamo; weight, 17 tons, with a capacity to operate motors using in all 250 h. p. This dynamo is to be used expressly for the purpose of developing current for operating motors.

The Hill Electric Company, Cincinnati, O., have removed their shops from Longworth street to 97 and 99 East Eighth street, and are now in better position than ever to serve their patrons with promptness and dispatch. They are making a specialty of repairing all kinds of electrical apparatus and are building small dynamos and motors.

The Northwestern Electric Supply and Construction Company, of Seattle, Washington, has recently been reincorporated under the name of the Northwest Electric Supply and Construction Company, with a paid up capital of $75,000. This is the pioneer company in the far Northwest, and has installed many of the electrical plants in that section.

The Electrical Supply Company, 171 Randolph street, Chicago, having finished up their house-cleaning in quick order, including the painting, calcimining and papering, have added some ornamental touches in the shape of artistically framed paintings, that call attention to the virtues of their famous shield brand wires, their Ajax battery and the Habirshaw insulated wires. The front show windows have also been beautifully decorated.

The Link-Belt Machinery Company have just broken ground to commence the erection of their new machine shop at Thirty-ninth street and Stewart avenue, Chicago. This building will be 400 feet long by 125 feet wide, three stories in height, and will be supplied with the latest improved machinery which will facilitate the handling of their rapidly growing business. An especial feature will be a traveling crane operated by electricity. Incandescent lights will be used.

Mr. Herbert A. Wadsworth, the Western manager of the Excelsior Electric Company, has moved his headquarters from No. 11 Adams street to the handsome suite of rooms, No. 125 The Rookery, on the Adams street front. As Mr. Wadsworth has ample storage room in the basement of the building the change is a most desirable one, and more especially as it brings him into immediate contact with every one entering what is now termed "The Electrical Building," rather than The Rookery.

The Cincinnati Consolidated Street Railway Company has now in successful operation an electric street railroad, running from Colerain avenue to Brighton, a distance of about three miles. The Thomson-Houston double trolley system is used. The Consolidated Company has also in the course of construction two more electric roads. The Thomson-Houston system will be used on both. The poles are being set and the work of getting the roads in operation is being pushed as rapidly as possible. They expect to have cars running in 60 days.

Telephone Quotations.—Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$290@$295	Cumberland	$ 59@ $60
Central Union	60@ 61	Wisconsin	116@ 117
Michigan	97@ 98	Bell of Missouri	140@ 145
Great Southern	30@ 32	Iowa Union	21@ 23
Colorado	38@ 40	Missouri and Kansas	54@ 55
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$100@$131	Chicago Edison Co	$115@$117

The Nowotny Electric Company, 80 East Pearl street, Cincinnati, O., are manufacturing and supplying the trade with a most excellent dry battery for all open circuit work. The outer

ell of this battery is made entirely of carbon, and has a carbon diaphragm dividing the two elements into two compartments, making it equivalent to two cells coupled in quantity. The battery is charged and ready for use when sold. It is said that this battery gives an E. M. F. of two volts and three ampères, with a resistance of but 1.6 ohms. They report large sales.

The McIntosh & Seymour Standard Compound Engine, through J. A. Grant & Co., 103 Adams street, Chicago, is meeting with excellent success in its introduction in the West. The ngine has made an enviable record for itself as a simple form of high-speed engine. The contract obtained from the Wisconsin Central Railway Company calls for the installation of one 150-h. p., one 200-h. p. and one 250-h. p. compound non-condensing engines to operate Edison dynamos. The bolts and templets for the foundations for this installation are now at hand, and the work is well under way. Mr. J. E. Wilson is at present in charge of the Chicago office.

San Francisco, Cal.—The municipal fire alarm system will be purchased by the city, and $4,000 of the purchase money will be retained to secure the city against damage by infringement.——The Pacific Electric Storage Company has received the contract from Davis Bros. to wire the Golden Rule Bazaar for a 270-light incandescent plant.——The Post Townsend Belt Line Electric Company has been granted a franchise and will begin work at once. A power house will be erected ,and cars will be run as fast as the road is completed, beginning about Sept. 1. The company has lately been incorporated with a capital of $150,000.——It is suggested that electric lights be placed on the top of street gas lamps so that the gas light may be visible.

The Electrical Supply Company, 171 Randolph street, Chicago, have obtained the selling agency for the Bradner adjustable hanger for incandescent lights, which was illustrated in The Electrical World of Feb. 8, and also shown to the delegates present at Kansas City. A decided improvement has been made in its construction, and in the artistic form now presented it should meet with ready sale, especially in modern office buildings. The Electrical Supply Company are also bringing out an improved form of lightning arrester known as the Wirt, and suitable for use on direct or alternate current circuits, for currents of high or low potential, and for pole or station work. It is one of the simplest forms of arresters yet devised, and requires in its operation no direct consumption of energy and no replacing of mechanical appliances. It is automatic in the full sense of the term and is always ready for use.

Removals.—Mr. F. J. Barker, the Western representative of the Daft Electric Light Company, has moved into room 456, The Rookery, where he will be glad to meet every one interested in light and power, and to talk about the excellent record made by the Daft car in Toledo.——The Illinois Anglo-American Battery Company have removed their offices from Dearborn street to rooms 23 and 24, 177 La Salle street, Chicago. Mr. J. B. McDonald remains as president and B. W. May as secretary of the company. They are now making a specialty of traction work, and are turning out cells in large numbers for that class of service.——Mr. H. W. Hill, manager of the Hill Clutch Works, Cleveland, O, inspected his new offices in The Rookery, in Chicago, this week. The removal of these offices to the electrical centre of the city is appreciated by all the members of the electrical fraternity.——Mr. F. A. Wunder, manager of the Western office of the Schuyler Electric Company, has secured the handsome office No. 456 in The Rookery, and will thus be more accessible to everyone interested in light and power.

Enterprising Railway Companies.—Kansas City, Mo., will soon have electrical facilities that will make its suburbs as easy to reach, almost, as its central points. The Kansas City & Independence Railway Company, organized in 1886 with a capital of $100,000, contemplates increasing its stock to $400,000, and building a first-class double-track electric railway between Kansas City and Independence. If the scheme is put into execution the power-house will be built about midway between the terminals, not far from Blue River.——At a recent meeting of the directors of the Kansas City & Blue Valley Electric Railway, the contract for construction and equipment was formally closed. The road will be completed by Sept. 1, and will co-operate with the Fifteenth street cable line. It is a matter of only a short time until this road will be extended to Washington Park, and eventually to Independence.——The construction of the suburban electricl ine on Troost avenue south to Brush Creek and west on Springfield avenue to Grand avenue has now become assured by the large influx of subscriptions received.——The extension of the Ivanhoe Park Electric Company is looked upon as a certain thing.

The Crandall Protector.—Interesting experiments were made with the Crandall protector for telephones against fire from heavy electric currents at the Electric Supply and Contracting Company's place, No. 32 West Third street, Cincinnati, O., a short time ago. Among the prominent people present to witness these experiments were Chief Jake Hughes, of the Cincinnati fire department; Henry C. Urner, assistant chief of the Fire Alarm Telegraph Company; Mr. Chas Marshall, superintendent of the Board of Underwriters; Mr. Delaney, superintendent of the Fire Alarm Telegraph Company; Mr. Luke Lilly, city electrician; Mr. I. W. Miller, superintendent of the Western Union Telegraph Company, and a number of other prominent electricians and insurance men. The protector is coupled into the telephone line in multiple, having a resistance sufficient to prevent the normal current from flowing through it. In case of a cross with an electric light wire or any wire carrying a current that would be dangerous to the telephone, the over-flow of current is shunted through the protector which is in the form of an electric magnet with resistance. The moment the overflow of current passes through the electro magnet an armature is drawn upward, opening the telephone line beyond the protector and near the telephone, closing a circuit through the protector to a ground wire, and completely shunting the current off from the telephone. There is also inserted in the line which leads to the protector a fuse that prevents it from being injured, at the same time opening the entire circuit. The experiments were successful in every way. It is to the interest of telephone companies to secure such an invention for the protection of their customers.

Cleveland News.—The Short Electric Railway Company are again enlarging their shops, and will soon be able to turn out five motors a day. Two cars will be sent in a week to the Pittsburg Traction Company. The sliding trolleys used on the Short roads are now fitted with carbon shoes, which give satisfaction. The shoes last several weeks and are then readily replaced at the cost of a few cents.——Mr. C. C. Curtis, General Agent of the Brush Electric Company, who has the management of the company's affairs in Ohio and Indiana, reports that business in his field is very active. He has recently made contracts at Rockport, Ind., for a 600-light alternating plant; at Jeffersonville, Ind., for a similar one; with the Otis Iron & Steel Company, at Cleveland, for a 30-light arc plant; also the following incandescent plants: National Screw and Tack Company, 200-light; Cleveland Varnish Company, 75-light; Quaker Mill, Ravenna, O., 75-light.——The Arcade Building, which is said to contain more wiring than any other building, will also have one of the largest isolated plants in the world. The Brush Electric Company has been given an order for a 60-light arc and a 300-light incandescent plant. The building is wired for 4,500 incandescent lamps.—The South Covington & Cincinnati Street Railway Company will run some Short electric cars soon, starting with eight motors and as many trailers. This will be a double overhead line.——The East Cleveland Railroad Company is putting guard wires above the trolley wires on the Euclid avenue line. The supporting wires are strung from wooden tips which fit over the tops of the regular poles. At the power house on Cedar avenue, carbon brushes are being used with satisfaction, set at an angle in the regular Edison brush-holders.——Mr. J. Potter, treasurer of the Brush Electric Company, reports the sale of a No. 8 arc machine each to E. W. Tisdall, Philadelphia; Electric Illuminating Company, New York; California Electric Company, for Sehome, W. T. ——At Muskegon, Mich., the change from horse cars to an electric system was completed two weeks ago. The result was a reduction in running expenses by fully one-half, while the income rose from $12 to $50 daily per car. It is easy to see why the company duplicated their order for two generators and five motor cars, each to draw a trailer. The Short, single overhead system is the one used.

F. de L.

SOUTHERN NOTES.

Camden, S. C.—Efforts are being made to organize a company for electric lighting.

Waynesville, N. C.—A locust insulator factory is about to be erected in this place.

Manchester, Va.—The Southside Land and Improvement Company has selected the Sprague motors for its electric cars.

Charleston, S. C.—The Southern Bell Telephone and Telegraph Company is changing its 500 wire switch-board for one of 800 wires.

Waycross, Ga.—Albertson, Murphy & Co., are adding to their electrical plant a 600-light incandescent dynamo and an 80 h. p. boiler and engine.

Rock Hill, S. C.—A company has been incorporated with a capital stock of $10,000. Incorporators: W. B. Wilson, Jr., David Hutchinson, R. T. Fewell and others.

Washington, Ga.—The Excelsior Manufacturing Company are building an oil mill, ginnery and fertilizer works, and will put in an electric plant, probably of sufficient power to light the town.

Lawrenceburg, Ky.—An electric motor railway is contemplated between this city and Greendale. The electric light company has nearly completed its building and is erecting poles. If no delays occur the current will be turned on May 1.

Mr. Harry Gessler, superintendent of the electric lighting system of Montgomery, Ala., has tendered his resignation, to take effect at once. Mr. Gessler has met with much success in his management of the system, and enjoys the reputation of a first-class electric light man.

San Antonio, Tex.—President Weiss, of the Street Car Company, denies the reported sale of the line, but says tracks will be relaid and new rolling stock added within ninety days. The present management, he adds, will remain for a time. It is reported, however, that a big deal of a secret character has taken place.

Consolidation.—As a last step necessary to complete the consolidation of the three electric light and the three electric railway companies at Richmond, Va., application was made to the judge of the City Circuit Court to amend the charter of the Old Dominion, and the Virginia Electric Light and Power Companies, so as to authorize them to lease, sell, or transfer their property, rights, franchises, and powers to the Richmond Railway and Electric Company, or any other company chartered for like purposes. The application was granted.

The Augusta (Ga.) Railway Company has been incorporated, with a capital stock of $300,000, and is building eight miles of double and four miles of single track. The power house will be on an excellent water site. Both steam and water power will be used. The station will consist of six Edison No. 32 compound-wound dynamos of 80,000 watt capacity; and 20 Brill cars, each equipped with two 15 h. p. Sprague latest improved motors, will be run over the line to all the principal points in the city and suburbs, including the village of Summerville, 2½ miles distant.

Memphis, Tenn.—The Merchants' Exchange is to have a new branch office of the Western Union Telegraph Company. Five wires will connect the office with Chicago, Kansas City, St. Louis, Louisville and Cincinnati, and will be for the exclusive use of members of the Exchange.——The property owners on Rayburn avenue appear to be much displeased because of the disturbance of their sidewalks caused in digging holes for the poles of the new electric railway. It is quite likely that this road will be better than the old one just abandoned, and by its excellence molify the displeasure of the property holders.——The first private residence in this city to have electric lights will be the one just contracted for by Hunter Raine. Wires will be put in to accommodate one hundred 16 c. p. incandescent lights.——Mr. Chas. E. Bibber, representing Holtzer-Cabot Electric Company, of Boston, was in the city this week on his way home *via* Nashville, Louisville & Cincinnati.——Poles have been put up by the City and Suburban Railway Company. They expect to have the Thomson-Houston motor driving cars on their road by June 1. The steam cars have been taken off, and a part of the old track is being moved to a better locality.——The Memphis Electric Light and Power Company has contracted to wire the Grand Opera House now under construction with 600 lights.

Y. N. B.

ENGLISH NOTES.

(*From Our Own Correspondent.*)

London, April 23, 1890.

A Dry Accumulator.—The Oerlikon engineering works, Zurich, have, I hear, for some time past been experimenting with an accumulator, the electrolyte of which is of a gelatinous nature, being formed by treating potassium or sodium silicates with sulphuric acid. The resistance, chemical reaction and method of charging are said to be the same as in the usual form of accumulator. The advantages of a dry electrolyte are obvious, especially for electric traction. The efficiency of the cell is said to be from 80 to 95 per cent. The efficiency of an accumulator, however, may be made almost anything one likes, so that the real value of this new form of storage battery can only be estimated when further details are published.

Electrical Trades Section of the London Chamber of Commerce.—The Electrical Trades Section of the London Chamber of Commerce held its annual general meeting on Monday. This section was formed a little more than a year ago, and holds with regard to the commercial side of electricity much the same position as that held by the Institution of Electrical Engineers to the scientific side. Mr. R. E. Crompton, in vacating the chair, briefly reviewed the labors of the past year; and considering that it was the first year of its organization, the Electrical Trades Section, it must be admitted, has not done badly. It has obtained valuable concessions from the promoters of the Electrical Exhibition at Edinburgh; it has commenced the work of collecting electrical data; it has approached the Board of Trade on the subject of a uniform (B. A.) screw gauge; and it has succeeded in bringing this reform considerably nearer; finally it has watched over the interests of the industry in connection with the government inquiry now being held on railway rates. Mr. R. E. Crompton was unanimously re-elected chairman, and the working committee was increased from 33 to 48.

Magnetic Disturbances.—At the last meeting of the Physical Society of London, Professors Rücker and Thorpe communicated some results recently obtained by them in the magnetic survey upon which they have been engaged for some time past. The phenomena observed by them has led them to assume as a provisional hypothesis that the variations are mainly due to the presence of large magnetic rocks. It is obvious that if this hypothesis be correct, the vertical component would be a maximum over the central portion of each mass of rock, and that the horizontal forces would be deflected toward this centre Last summer, in order to test whether their facts fitted with their theory, Professors Rücker and Thorpe selected two districts for more minute examination. The districts were the west coast of Scotland, and Lincolnshire and Yorkshire.

The magnetic map of the latter district exhibited a magnetic ridging along which the local variation from the vertical force was a maximum, while the horizontal forces on either side of the line were deflected toward it. The result of their investigations on the west coast of Scotland led them to conclude that there was a large mass of submerged rock on the southwest coast due south of the Hebrides. On analyzing the observations made by Welsh in 1859 and 1860, it was found that they led to the same conclusion. An application has been made to the Royal Society to assist in carrying this useful work further. It promises to add considerably to our knowledge of the causes of local magnetic variations.

Board of Trade and the Electric Light.—A striking example of the treatment to which electric lighting companies are subjected in this country has been afforded by the action of the Board of Trade in regard to the Eastbourne Electric Light Company. For some years past this company has been doing good work in this fashionable seaside town without parliamentary powers. Owing, however, to an intimation that its operations must be carried on under a provisional order, a provisional order was applied for a few months ago. At a meeting of the Eastbourne Town Council held last week a letter was read from the Board of Trade, stating that they thought that the Town Council should insist on the price per unit (1,000 watt-hours) being fixed at 8d., instead of 10d. A few councillors, indeed, expressed surprise that the Board of Trade should take upon itself to regulate prices in this summary fashion; but in the result the Town Council decided that there was no reason why the Board of Trade fixture of 8d. should not be accepted. Now the Eastbourne Electric Lighting Company have from the beginning asserted that they are unable to make a profit out of less than 10d. per unit, and considering the price of coal and other circumstances connected with this town, I see no *prima facie* reason for doubting this statement. At any rate we have the Board of Trade, after the question of price had been amicably settled between the Electric Lighting Company and the Town Council, intervening and practically ordering the company to supply electricity at a loss.

THE TELEGRAPH.

Frankfort, Ky.—A bill has been introduced in the Kentucky Legislature, now in session, to incorporate the Big Sandy Telegraph Company.

A New Telegraph Line has just been completed between Wilmington and Fayetteville, N. C., on the lately finished Cape Fear & Yadkin Valley Railroad.

A new telegraph pole has been constructed of tubular malleable iron, galvanized, 2½ inches at the top. The pole weighs but 50 pounds, and will stand a much greater strain than ordinary poles The bottom is set in a clam plate 6 inches square, which grips the ground. The pole has been tested and gives satisfactory results.

The Postal System.—Mr. F. W. Jones, the assistant general manager and electrician of the Postal Telegraph Cable Company New York, and a prominent member of the New York Press Club, has been in Chicago some three weeks installing the electric plant in the basement of the Traders' building, to furnish current for the postal system. The plant consists of 16 generators of the improved direct current type of the United States Company, driven from line shafting that is connected by clutch pulleys to two 10-h. p. United States (Weston) motors. The current for the latter is supplied from the central station of the Chicago Edison Company, and is fed through two independent sets of machinery, thus doing away with a possibility of failure in the supply requisite to drive the machinery. The 16 generators are wound for various potentials ranging from 35 volts to 375 volts, and yield in energy from 1,000 watts up. The machines of lesser potential will be used on the wires known as "the locals," "the cities" and "the legs,' the "main wires" and "the quadruplexes', taking the heavier currents. All the machines rest on a solid self-sustained oak frame, the posts of which are imbedded in the concrete floor and not connected to either the wall or the ceiling of the room, thus doing away with all possibility of vibration, a feature s annoying in many buildings. Mr. Jones has given the installation the utmost care and has personally supervised every detail, besides adding several features that, while novel, aid largely in rendering the system automatic. The plant will be turned over in full operation to Mr. James E. Pettit, the manager of the Chicago office, on Sunday next.

THE TELEPHONE.

The Telephone in the Mikado's Empire—At the cost of the State a line of telephone between Yokohama and Striznoka, a distance of about 100 miles, has been constructed. This is the first telephone that has ever been applied to the Japanese public service. The operation has so far been satisfactorily successful.

Austin, Tex.—A large dam is about to be built near here on the Colorado River, and the plans and specifications for the work have already been submitted. The object is to use the water power for electric light and power works. The cost of dam, reservoir, gate-house, mains, pumping and electric plants, etc., is estimated at $1,370,000. The company will issue $1,500,000 of bonds to cover the expense of the work.

Long Distance Telephone Lines.—Manager Gentey, of the Atlanta Telephone Exchange, has been at West Point, Ga., several days arranging for the construction of a telephone line between Atlanta and West Point. The telephone company has determined upon the construction of long distance lines wherever they receive substantial encouragement. They have decided upon a line from

Atlanta to Newman, and also one to Stone Mountain and Lithonia. Others are to be built as rapidly as there is demand for them.

THE ELECTRIC LIGHT.

Bellows Falls, Vt., will soon be lighted by 30 arc lamps.

Anderson, S. C., will soon establish an electric light plant.

Brenham, Tex., has an electric light plant in contemplation.

Darlington, S. C., is about to put in its own electric light plant.

Tredagar, Ala.—The erection of an electric light plant is contemplated.

Norwood, N. Y.—This place will soon establish an electric-light plant.

Chaska, Minn., is considering a proposition to install an electric light plant.

Atlantic, Ia.—A company has been organized to erect an electric light plant.

Swampscott, Mass.—Efforts are being made to establish an electric light plant,

Brunswick, Ga.—A company is being organized to erect an electric light plant.

Abilene, Texas.—A franchise has been applied for to erect an electric light plant.

New Brighton, Ill.—The New Brighton Electric Light Company has been incorporated.

Johnson City, Tenn.—Improvements will soon be made by the local electric light plant.

Camden, Ark.—The electric light company contemplates putting in an incandescent plant.

Cedartown, Ga.—R. O. Root is endeavoring to secure the erection of an electric light plant.

Lampasas, Tex., has by popular vote declared itself in favor of establishing an electric light plant.

Carrollton, Ga.—A capitalist of Tallapoosa contemplates erecting an electric light plant here.

Harlman, Tenn.—The Westinghouse Electric Company will install a 50-arc light alternating plant.

Cherokee, Ala.—An electric light plant is about to be established in this place at a cost of $10,000.

The Fort Worth, Tex., City Council has ordered the erection of a $27,000 electric light plant.

Radford, Va.—The Central City Electric and Gas Light Company has been organized with S. Heth, president.

A San Antonio (Texas) company has applied for a franchise to erect an electric light plant and water works.

The New Castle (Va.) Land and Improvement Company contemplates establishing an electric light plant.

North Yakima, Wash., will shortly be lighted by electricity, the material for the plant having recently arrived there.

Taylor, Texas.—The Taylor Electric Light, Ice & Power Company has been incorporated, with a capital stock of $40,000.

The Cheltenham (Pa.) Electric Light, Heat and Power Company has been incorporated, with a capital of $50,000.

The Collinsville (Ills.), Electric Light, Heat and Power Company has been incorporated, with a capital of $25,000.

Parkersburg, W. Va., will, on the expiration of the present contract for lighting the streets, erect an electric light plant.

The Union (Ore.) Electric Light and Power Company will establish an electric light at an estimated cost of $100,000.

Dover, N. H.—The Cocheco Manufacturing Company is putting in an incandescent plant, Thomson-Houston system, for its own use.

Bedford City, Va.—The City Council has made arrangements with the electric lighting company of this place for lighting the entire city.

Westfield, N. J.—Contracts for a complete service of electric street lighting at a cost of 45 cents per lamp per month have been completed.

Brookline, Mass.—It is reported that the authorities are going to discuss the desirability of establishing a municipal electric lighting station.

The Trustees of Fairhaven, Vt., have received instructions to have the streets lighted by electricity for one year at a cost not exceeding $1,500.

Long Branch, N. J.—A new electric light company has begun operations, using 200 arc and 600 incandescent lamps of the Thomson-Houston system.

Madison, N. J., has circulated a petition calling for a special election. The issue is to bond the borough for $75,000, for electric light and water supply.

The Chicago Illuminating Company has been incorporated to furnish electric light and power; capital stock, $500,000; incorporators, T. S. Wheaton, D. S. Gooding and E. M. Miles.

Reno, Nev.—The electric storage lighting plant recently installed in the asylum in this place is reported as giving thorough satisfaction, and as having worked without trouble from the start.

Butte, Mont.—The electric light company has secured a location near the Montana Central Depot in South Butte, to which it is about to remove its plant. The company supplies power for 600 lamps.

Charleston, W. Va.—The present electric light company is not large enough to meet the demands made upon it, and immediate steps are to be taken toward the erection of an electric light plant by the city authorities.

Electric Lights in Idaho.—The Boise City electric plant consists of 1,000 lights; Blackfoot is using 500-lights, Moscow has a 750-light plant, and Hailey a 500-light plant. Caldwell has ordered a 500 and Wallace a 650-light plant.

Harrison, O.—Permission has been asked by a majority of the old Town Council to issue $50,000 worth of bonds for the purpose of purchasing an electric-light plant for lighting streets, putting in sewers, building water works and improving streets.

Schidznoka, Japan.—The Westinghouse Electric Company is to supply the Tokato Company of this place with an electric plant for 5,000 lights. It is expected that many other plants will be erected upon the successful operation of this, the first electric lighting plant in the country.

Cohasset, Mass., is to be illuminated by electricity, and a central station will be erected at once near the Old Colony depot. The beautiful marine drive known as Jerusalem Road will be extended and lighted throughout its entire length.

The North Shore Electric Company has contracted to furnish Revere, Mass., for a term of three years, with 175 incandescent lights of 26 c. p., at a cost of $16 a year each, and also 15 arc lights of 1,200 c. p., at a cost of $72 a year each, the lights to burn from sundown to 12:30 A. M.

The Marysville Electric Light and Power Company, of Marysville, Cal., has been incorporated, with a capital stock of $20,000, for the purpose of producing electricity for power and light. Incorporators, Jos. Heyl, C. A. Glidden, N. V. Nelson, Theo. Nelson, W. F. Keeley and Jas. O. Reesby.

A Remarkable Lamp.—The Queen City Electric Light Company, of Gadsden, Ala., say they have a lamp that has been burning twelve hours per night ever since July 4, 1888, and at last accounts was still going. This lamp is a Sawyer-Man 16 c. p., 110 voltage, and its record of 8,000 hours is certainly remarkable.

The Metropolitan Museum of Art is now lighted by electricity. The experimental lighting tried Saturday evening, May 3, was a complete success. Two Sweet engines are used, and the galleries and floor are lighted with 3,000 incandescent lamps. The plant is an unusually large one, there being but few larger in the country.

The Mercantile Committee, on April 30, reported a bill to authorize the Boston Electric Light Company to increase its capital stock to an amount not to exceed $2,000,000, making the entire capital stock $3,000,000. The new stock may be issued or sold from time to time in accordance with existing laws relating to the increase of capital of manufacturing corporations.

The Suburban Electric Light and Power Company, Boston, have built a line from their station on Norfolk avenue to the Dudley street station of the N. Y. & N. E. R. R. The company are wiring the Hotel Langham for 250 16 c. p. incandescent lights. They arealso extending their lines along Tremont and Washington streets, where they have contracts for lighting a large number of stores and offices with both arc and incandescent lights.

Altoona, Pa.—The Pennsylvania Railroad Company are about to install a large arc light at their new Juniata shops in East Altoona. It is thought that the Westinghouse alternating system will be used. About 200 lamps will be required. The Westinghouse compound engine will be used throughout, steam being carried at 160 pounds pressure. Two hundred or three hundred Edison incandescents will be used also.——An excellent and safe piece of electric wiring is that recently done at the paint shops of the Pennsylvania Railroad Company here. Mr. J. D. Burleigh executed the job, under the direction of W. H. Maukland.——Mr. E. B. Greene, superintendent of the Edison Illuminating Company, is very much pleased with his new engine, built for this special service by the Altoona Manufacturing Company. The Edison Company has secured a three years' contract to light this city with 80 arc lamps of 2,000 actual candle power, at $75.50 per lamp per year.

The Westinghouse Company.—The introduction of the Westinghouse alternating current arc light system is growing in popular favor. The company is constantly in receipt of complimentary letters which testify to the many advantages of the system. The demand for the alternate current arc light apparatus is increasing at a wonderful rate, and the productive capacity of the Pittsburgh works is tested to its very utmost. Of late many inquiries have been made for a smaller dynamo than the ordinary 60-light machine. To meet this demand the company is now manufacturing a small 25-light dynamo of a unique but very pleasing design. During the month of April the Westinghouse Electric Company sold its alternate current incandescent apparatus for central stations electric lighting plants in the following places: Portsmouth, Va., 1,500 lights; Saratoga, N. Y., increase, 1,500; Salt Lake City, Utah, 500; Mt. Morris, N. Y., 500; Brookline, Mass., 900, increase; Johnstown, N. Y., 500, increase; Springfield, Mass., 3,000, increase; St. Thomas, Ontario, 750; Ouray, Colo., 750; Sherman, Tex., 750; Detroit, Mich., 6,000; Susquehanna, Pa., 750; Elmira, N. Y., 750, increase. The Westinghouse alternating current arc light apparatus has been contracted for during the month of April by electric light companies at the following central station plants: Troy, N. Y., 60; Saratoga, N. Y., 60; Salt Lake City, Utah, 25; Evanston, Ill., 120; Joliet, Ill., 60; Martin's Ferry, O, 40; Uxbridge, Mass., 60; Oxford, O, 60.

APPLICATIONS OF POWER.

Holliston, Mass.—An electric railway is to be built.

Winthrop, Mass.—An electric street railway is talked of for this town.

Winchester, Ky.—The Winchester Street Railway Company are considering the plan of operating their road by electricity.

The Oregon City (Ore.) Street Railway Company has been organized, and has its principal place of business in this place. The company starts with a capital of $25,000.

Sunbury and Northumberland, Pa.—The electric railway between these places was formally opened last week. The first car, with the road officials on board, attained a speed of 20 miles an hour.

Quincy, Mass.—The contract for the building of the Wanet street railway to Hough's Neck has been awarded to Saul Bellingham & Company, of Boston. Work will begin on the road at once, and it is expected to be in running order by June 10.

Gardiner, Me.—A. F. Gerald, of Fairfield, and other capitalists are proposing to build an electric railway to run between this place and South Gardiner, four miles below the city proper, New Mills, a mile from the city, and several other points. The chances are in favor of the accomplishment of the scheme.

Electric Freight Transportation.—The electric street railway recently put in operation at Victoria, B. C., has met with such success that the company proposes to extend its tracks to the rural districts and handle freight. The same scheme may come into operation at Vancouver and Westminister.

At Richmond, Va., the South Side Land and Improvement Company is building an electric street railway that will run from the property of that company in Chesterfield County, through Manchester, across the James River, over the Free Bridge, and along Seventh street, in Richmond. The Sprague system has been adopted for their electric cars, and the contract for electric motors has been awarded to that company. It is expected that the cars will be running over most of the line by July 4.

Electric Locomotive.—Considerable interest was manifested to-day in the appearance on Washington street of the new electric locomotive built for the West End Railway Company. It is so heavy that six horses were needed to draw it. It can run twenty miles an hour, has a fender much like the cowcatcher of a steam locomotive, and will be run purely on an experimental basis by the West End Railroad. It is operated by the overhead system. Although capable of drawing four cars, it probably will not be given a chance to do so in real service, not more than this "locomotive" and one other car being run at one time.

PERSONALS.

Willis Gurney, of the Thomson-Houston Works, at Lynn, Mass., who is to assume a position in the employ of the Edison Company, of New York, received a fine French marble clock Monday evening from his friends of the South Street Methodist Episcopal Church.

Mr. W. J. Hammer, who was Mr. Edison's representative at the Paris Exposition, has returned from a two-months' sojourn in Florida, looking very much improved by his trip. Mr. Hammer had charge of the Edison exhibit at Paris, and worked hard, and his health suffered in consequence. His friends will be glad to know that his vacation in the South has benefited him so much.

MISCELLANEOUS NOTES.

Pittsburgh, Pa.—A charter has been granted to the Nichols Electric Mining Company. Capital, $500,000.

The Harrisburg (Pa.) Car Manufacturing Company has just supplied a 75 h. p. engine of its special type to the Bucksport, Me., Electric Light Company.

The Perkins Lamp Company, Hartford, Conn., has re-elected its old officers and board of directors, and has declared a 10 per cent. dividend on its 1,000 shares of stock.

The King Philip Electric Company, of Bristol, R. I., are manufacturing a new dry battery which is attracting much attention. They have received some very flattering letters from electricians and others who have tried it.

The Essick Printing Telegraph Company are sending out solicitations for bids for a ten-wire copper line from Boston to New York, which they propose to build at once. S. V. Essick, the inventor of the system, was in Boston last week.

College Men Going into Electrical Works.—Six young men of this year's class of Cornell University will go direct from the college to Westinghouse, Kerr & Co's works in New York City, and a number of others to the Westinghouse works in Pittsburgh.

The Electric Street and Station Indicator Company, San Francisco, Cal., has filed orders of incorporation; $420,000 of the capital stock of $500,000 has been subscribed. Directors: John L. Cahill, Lucius H. Foot, Alex. G. Hawes, Joseph D. Grant and Reuben Lloyd.

A New Insulating Material.—Dr. Purcell Taylor, 26 Marchmont street, Russell Square, London, Eng., claims to have discovered a new insulating material that costs only one-fortieth part of the price of gutta percha, while it offers a greater electric resistance. The new material, he says, is very strong, may be made either flexible or rigid and of any color, and any melting point may be given it.

The Mill and Mine Electric Equipment Company report having equipped the Armstrong mine with Hercules mining machines and Tesla motors, eight coal mining machines, Westinghouse generator, and a 50 h. p. Westinghouse engine. They have commenced a lighting plant in the first-pool Monongahela Gas-Coal Company's mines at Wilcox, Pa., consisting of 150 incandescent United States lamps, entire capacity, 200; also an increase of five Westinghouse mining machines has been supplied to this company.

The New England Electrical Safety Company, sub-licensees of the Electrical Safety Company, have organized and elected the following officers: Hiram Simmons, president; C. F. Atherton, secretary and treasurer. Capital stock $100,000, divided into 20,000 shares. This company has the exclusive right for the New England States to use and vend the protector. The parent company retain the right of manufacture. The New England Company are agents for the Sprague motor, also, and have several 25 h. p. motors in use in Boston.

American Institute of Electrical Engineers.—The following gentlemen were elected to associate membership in the Institute at the Council Meeting, April 15, 1890: G. W. Palmer, Jr. General Manager McKeesport Light Company, McKeesport, Pa.; W. F. Bauer, Constructionist, The Electrical Accumulator Company, 62 Steuben street, Orange, N. J.; George B. Shaw, General Manager, National Electric Manufacturing Company, Eau Claire, Wis.; J. J. Carty, Electrician, Metropolitan Telephone & Telegraph Company, 18 Cortlandt street, New York; Arthur Churchill, Electrical Expert, Frazar & Co., Yokohama, Japan; Warren S. Belding, Electrician and Superintendent, The Belding Motor and Manufacturing Company, 6,423 Stewart Boulevard, Chicago, Ill.; Herbert H. Eustis, President and Electrician, Eastern Electric Cable Company, 61 Hampshire street, Boston, Mass.; Marmaduke Burrell Holt, Student, Course of Electrical Engineering, Columbia College, New York; W. D. MacQuesten, Field Engineering Company, 15 Cortland street, New York.

BUSINESS NOTICES.

Mr. George B. Prescott, Jr., who, up to the present time has been the consulting electrician and expert of the Electrical Accumulator Company, has accepted the general agency for Day's Kerite insulated wire and cables. Mr. Prescott's indorsement of the Kerite goods certainly lends added weight to the company's claims.

The Jerome-Kidder Mfg. Co.: I am well pleased with the cabinet battery. Whenever opportunity warrants, I shall recommend it as the best stationary battery in the market. And I have had hospital and private acquaintance with all for a numer of years.

DR. R. S. NEWTON.

NEW YORK, 103 East Sixteenth street, March 7, 1890.

Mr. Wells Goodhue, the well-known manager of the house-goods department of the Electrical Supply Company, 171 Randolph street, Chicago, has just returned home from an extended trip to the Pacific slope, undertaken for the purpose of introducing the Ajax dry battery to the trade. The trip proved far more successful than was anticipated, and orders for many thousand cells were secured.

The Ball Engine Company, of Erie, Penn., have the following orders on their books for their special vertical engines adapted for electric lighting on ship-board: Four vertical compound engines for the United States gun boats "Concord" and "Bennington," ordered by the United Edison Company; one vertical compound engine for New York Life Insurance Company, of Minneapolis, Minn., ordered by the Brush Electric Company; one vertical compound for new steamer for the Brazilian Steamship Company, ordered by The Complete Construction Company, of New York; two vertical double engines, ordered by the Brush Electric Company for the United States steamship "Miantonomoh"; two vertical compound engines, ordered by United Edison Company fo steamer "Plymouth," of Old Colony Steamship Company,

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED APRIL 29, 1890.

426,436. Trolley Equalizer; George F. Corliss, of Mansfield, O. Application filed July 30, 1889. In a trolley equalizer, the combination of a trolley, cords connected thereto, drums on which the cords are wound, and spring actuated sliding blocks connected to the drums.

426,437. Electric Heater; Charles W. Drew and Edward R. Francis, of Minneapolis, Minn. Application filed Feb. 20, 1890. The invention consists in providing a series of coils of resistant wire or metal supported upon strips or supports having a surface of insulating material and arranged within a suitable casing upon a base of electric insulating and non-heat conducting material with a heating plate arranged over but not in contact with the coils.

426,452. Crossing for Overhead Wires.—John Kuehnle of Detroit, Mich. Application filed March 11, 1890. In a crossing for electrical wires, the metallic bridges, each formed with double loops connected by a crossbar in different planes and joined together by a block of insulating material secured between the respective loops and crossbars of the bridges.

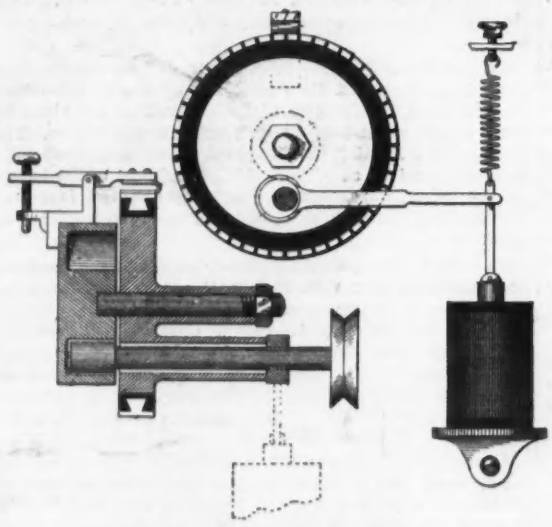
426,471. Brush and Holder for Electrical Machines: Edwin Wilbur Rice, Jr., of Lynn, Mass. Application filed March 30, 1889. In an electric commutator, a carbon contact block having a copper envelope, in combination with a block or receptacle of copper in which the copper slides up and down and a laterally pressing spring against the block to hold it in position.

426,479. Apparatus for Manufacturing Electric Light Carbons; Henry A. Tremaine, of Cleveland, Ohio, Assignor to the Standard Carbon Company, of same place. Application filed Aug. 30, 1889. The combination, with conveyers, tables extending latterly therefrom, carbon receptacles at one end of the tables and heaters at the opposite ends, with ways between the carbon receptacles and heaters adapted to receive the molds, and a press arranged in line with the conveyers.

426,499. Device for Measuring Electrical Currents; Thomas H. Hicks, of Detroit, Mich, Assignor to the Electrical Invention Company, of the same place. Application filed Sept. 9, 1889. In a device for measuring electrical currents, the combination of the current unit measuring device, the unit resistance in which it is included, the series of graduated resistances in shunt circuits therewith, and representing fractions of the units of resistance, and the series of graduated resistances forming multiples of the unit of resistance and connected together in series with each other and the current unit device.

426,522. Electrical Train Signal; George D. Burton, of New Ipswich, N. H. Application filed Nov. 22, 1887. For train signaling, the combination, with three co-extensive conductors extending throughout the train, inclosed in a cord and forming two distinct electrical circuits, the one for establishing communication from engineer to conductor, with circuit controllers each of which has a pivoted lever, the cord inclosing the wires acting as a bell or pull cord for operating the levers.

(1) 426,554. (2) 426,555. Message Recording Instruments; John C. Wilson, of Boston, Mass. Applications filed (1) June 25, 1888. (2) Oct. 29, 1889. (1) In a register, the normally



No. 426,570.—Regulator.

wound motor, releasing lever, and starting magnet, combined with the recording pen and marking roller, between which the paper is fed, the ink roll and the reservoir in which it revolves, the ink-conveying roller bearing upon the marking roller and journaled in a frame, and a movable rod supporting the frame, movement of which rod brings the said ink-conveying roller into and out of contact with the ink roller. (2) In a message-recording instrument, as ink reservoir, a roller contained in it, and a manual revoluble conveying roller bearing thereon, combined with a marking roller and an ink roller bearing on it and movable into and out of contact with the manually revoluble conveying roller.

426,563. Induction Coil; A. M. Frankenberg, of Baltimore, Md. Application filed June 21, 1889. The combination, with an induction coil having two primary circuits through which the current flows alternately in opposite directions, and an ordinary unpolarized armature, of a permanent magnet arranged so that the armature will be in the field of force of the magnet, the polarity of the armature end of the coil being opposite that of the presented magnet when the current flows through the primary in one direction and of the same polarity when the current flows in the other direction.

426,570. Regulator for Dynamos and Motors; William T. Peel, of St. Paul, Minn., Assignor of one-half to Jacob R. Steiner, of same place. Application filed July 12, 1889. A regulator for a dynamo electric machine or motor consisting of a disc carrying a switch arm, a series of contacts over which the switch arm moves, the disc provided with an annular groove, a continuously rotating friction pulley located in the groove, and mechanism controlled by the main circuit for throwing the friction pulley into contact with one or the other of the walls of the groove.

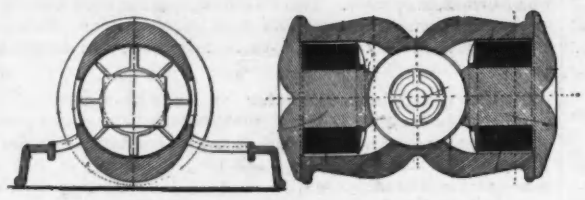
(1) 426,573. Potential Controlling Device. (2) 426,574. Regulation of Electric Motors; William Stanley, Jr., of Great Barrington, Mass. Application filed (1) July 3, 1888. (2) July 10, 1888. (1) The combination of a generator of electricity, mains leading therefrom, a third wire connected to one of the mains, a differential magnet having one of its coils in circuit between the mains and the other in circuit, between the third wire and the main to which it is connected, and a potential controlling device actuated by the magnet. (2) The combination of a generator of electricity, mains leading therefrom, electromotors in circuit between the mains, a third wire attached to one of the mains at the electrical centre of distribution, and regulating coils upon the motors connected between the third wire and the main to which it is attached.

426,576. Dynamo Electric Machine; Jonas Wenstrom, of Orebro, Sweden. Application filed Aug. 31, 1889. The combination, with interior cylindrical iron cores situated on both sides of the armature and cast in one piece with pole pieces on the ends facing the armature, and with back yokes on the other end, and surrounded by cylindrical magnetizing coils, of an outer enveloping casing, the interior surface of said casing being cylindrical, but the exterior of an oval shape, of such arrangement that the thickest parts of the casing will be situated at a plane laid through the axis of the field magnets and perpendicular to the armature shaft.

426,580. Electric Railway; Edward M. Bentley, of New York, N. Y. Application filed Jan. 20, 1888. In an electric railway an insulated supply conductor supplied with a series of movable exposed contacts normally in circuit with the supply conductor, but out of the path of travel of the contact device, in combination with a contact conductor attached to a vehicle on the railway, and of a length equal to the distance between thesaid exposed contacts and means controlled by the presence of the vehicle for successively bringing the contacts into engagement with the traveling contact device.

426,583. Switch Apparatus; Minor M. Davis, of Brooklyn, N. Y. Application filed June 11, 1889. In an electrical switch apparatus, the combination, with a spring jack having one of its contact jaws subdivided, and a branch or circuit connecting the divisions of the contact, of a wedge having a live side adapted to bear on both subdivisions simultaneously, and an appendant circuit, for the purpose of replacing the former circuit with the latter.

426,591. Quadruplex Telegraphy; Francis W. Jones, of New York, N. Y. Application filed Jan. 3, 1889. The invention consists in the combination with the two field magnet coils, of



No. 426,576.—Dynamo Electric Machine.

switch devices whereby they may be included either in series or in multiple arc, as desired, in combination with an artificial resistance in the series connection with the coils, as well as in connection or common return formed when the coils are in multiple arc.

426,621. Electric Signaling Apparatus; James J. Mackenzie, of New York, N. Y., Assignor to the Gamewell Fire Alarm Telegraph Company, of same place. Application filed Oct. 9, 1883. Patented in England April 11, 1883. In electrical signaling apparatus, the combination, with a spindle having two or more series of contacts and spaces arranged longitudinally thereon and adapted to be adjusted axially to bring into position any one of the series of contacts and spaces of a revolving contact spring passing over the contacts and spaces of the spindle.

426,650. Electric Engine; Robert W. Thompson, of Cleveland, O., Assignor of one-eighth to George W. Tibbetts and James C. O'Neil, both of same place. Application filed Jan. 23, 1890. The invention consists of a dynamo and a motor for running it, a storage or receiving battery and a motor for power or propulsion combined and arranged in close juxtaposition, whereby electricity is generated, stored, and employed within a very small compass without loss or diminution by long conducting appliances.

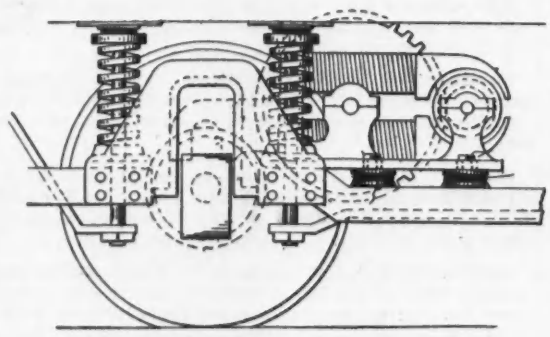
(1) 426,657. (2) 426,658. Electric Motor Car; John A. Brill, of Philadelphia, Pa. Applications filed Feb. 18, 1890. (1) An electric motor car having a motor located above the car floor and supported at one end by an arm or arms journaled on a car axle and at the other end supported on the car, and gear connection between the motor and axle. (2) In an electric motor car, a motor located entirely above the car floor, arm or arms journaled at one end on a car axle for supporting one end of the motor, a bracket secured to the car floor within the car body for supporting the other end of the motor, and gear connections between the motor and axle.

426,688. Electric Fire Alarm; Charles H. Shaffer, of Rockford, Ill., Assignor of one-half to Jones Woodruff & Co., of same place. Application filed May 25, 1889. In an electric fire alarm, the combination of a normally closed circuit and a normally open circuit a battery common to both circuits, the closed circuit, including removable thermostats, the thermostats consisting of a base, the circuit wires connected to the base, and a detachable link of fusible alloy connecting the circuit wires, an electro magnet, and an armature held by the electro magnet, whereby the opening of the closed circuit by the action of heat releases the armature, which moves out of the field of the electro magnet, thereby closing the open circuit, and transferring the battery force from the closed circuit to the open circuit, in which is located an alarm bell.

426,691. Fire Alarm Telegraph System; John Speicher, of Jersey City, and Frederick T. Fearey, of Newark, N. J., Assignor to the Newark District Telegraph Company, of New Jersey. Application filed Feb. 15, 1889. In a fire alarm box, the combination, with the circuit wheel train inclosed in an inner case, a locking bar controlled by an escapement, a magnet, an armature arranged on a lever, the lever extending from engagement with the circuit wheel train through the casing into engagement with the escapement, whereby the said circuit wheel train may be released after a series of changes or impulses produced by the magnet train.

426,699. Regulator for Dynamos; James J. Wood, of Brooklyn, N. Y. Application filed August 20, 1889. The combination, with a dynamo electric machine, of a regulator therefor, consisting of two auxiliary brushes applied to opposite sides of the commutator in position of like and equal potentials, a conducting bridge connecting the brushes, a shunt from the brushes to a brush or brushes in contact with commutator segments of opposite or different potential, and a variable rheostat in the shunt.

426,705. Circuit Closing Hinge for Electric Burglar Alarms; William M. Bleakley, of Verplanck, N. Y. Application filed Feb. 15, 1890. The combination, with a hinged leaf and



No. 426,708.—Electric Railway Car.

an insulated leaf spring thereon that is adapted to make and break electrical connection with a mating hinge-leaf, of an electrical conductor terminal secured to the insulated leaf spring, and a circuit completing electric conductor terminal secured to one of the hinge-leaves.

426,706. Burglar Alarm; John H. Bleoo, of Brooklyn, Assignor to the Mutual District Telegraph Company, of New York, N. Y. Application filed Aug. 5, 1889. A burglar alarm comprising a spring terminal, bowed or inclined from its attaching point toward its free end, and a catch constituting an opposing terminal, under which the free end of the spring may be held and movable in the direction of the length of the spring, the tendency of the free end of the spring being to spring away from the catch to break an alarm circuit, whereby the two parts of the alarm may be locked together between the meeting edges of a door and its frame, and set for action by closing the said door to flatten the spring and cause it to push the catch.

426,708. Electric Railway Car; John A. Brill, of Philadelphia, Pa., Application filed May 18, 1889. In a car the combination of a motor mounted upon and wholly or entirely supported upon a frame not subject to the action of the car springs, and having guide arms in engagement with one of the axles of the car to keep the axle in parallel alignment with the motor shaft or shafts.

426,724. Method of Making Electrodes for Secondary Batteries; George Edward Heyl, of Charlottenburg, Prussia, Germany. Application filed June 8, 1889. The method of making electrodes of secondary batteries, which consists in suspending vertically a number of wires or threads of lead, then simultaneously directing against the suspended wire or threads a plurality of streams or currents of air in different directions, whereby the wires or threads are intertwined and entangled, and then consequently compressing the intertwined and entangled wires or threads.

426,749. Automatic Telegraph; Frank Anderson, of Peekskill, N. Y. Application filed Sept. 30, 1889. The described method of giving increased effect to the signaling impulses or currents transmitted over a telegraphic or anologous electrical circuit, consisting in setting up simultaneously a second set of electrical currents or impulses which have a greater potential than the signaling impulses.

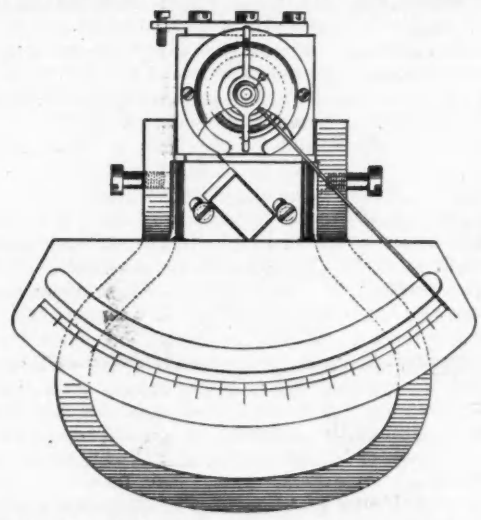
426,781. Electric Refrigerating Apparatus for Railway Cars; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed Feb. 10, 1890. The invention consists, in the combination, in a system of cooling cars by electricity, of a moving car, a dynamo-electric machine carried on the car and having its armature mechanically connected to the axle or wheel of the vehicle, and to be driven by the latter, conductors connected to the dynamo, an electric conductor having one or more parts adapted to be cooled by a current, and a secondary battery in parallel circuit with the dynamo, and suitable current-controlling devices.

(1) 426,788. Apparatus for Producing Sheets of Metal by Electricity. (2) 426,789. Electrolytic Apparatus for Forming Copper Ingots; Moses G. Farmer, of Eliot, Me. Application filed July 29, 1889. (1) In an electrolytic apparatus, the combination, with the anodes supported in a solution in a tank or vat, of a revolving cathode mounted in the solution being polygonal or made up of a number of plain facets. (2) In an apparatus for forming sheet metal, the combination, with an electrolytic vat or tank, the forms or blocks partially filling the same, and curved anode plates supported thereon, of a cylindrical cathode mounted in the tank and capable of rotation therein.

426,819. Duplex and Quadruplex Telegraph; Francis W. Jones, of New York, N. Y. Application filed June 11, 1889. In a quadruplex or duplex telegraph apparatus, an artificial variable resistance interposed on the main line between the key system and the dividing point of the main and artificial lines, in combination with dynamos and receiving instruments, for the purpose of regulating the outgoing current and forcing the incoming current into the convolutions of the artificial line around the receiving magnets.

426,832. Automatic Fire Extinguisher; Joseph Madden, Providence, R. I. Application filed Dec. 24, 1889. An automatic fire extinguisher, consisting of a thermostat and an electromagnet included in a circuit, the magnet designed when energized to tilt a plate and roll a weight from the plate to the end of a lever operating a water valve.

426,917. Thermostatic Circuit Closer; William H. Chambers, of Fulton, Ky., Assignor of one-fifth to Jesse T. Holman, of Harris Station, Tenn. Application filed Dec. 21, 1889. A thermostatic circuit closer comprising a base made of an insulating material, two spring arms secured at one end to the base in such manner that their free ends may spring together, the free ends of each arm having a quarter twist, cords attached to the arms for



No. 427,022.—Electrical Measuring Instrument.

holding them normally apart, and circuit connections arranged as described, whereby the circuit will be closed when the arms are released.

426,932. Galvanic Battery; Fernand Gendron, of Bordeaux, Gironde, France. Application filed Feb. 8, 1889. In an electric battery, the combination, with an exterior casing, of a porous cell formed in one long piece with connected parallel compartments. The electrodes consist of a series of metallic plates superposed upon each other, each plate being amalgamated upon both sides and held together by the flanged frame.

426,941. Telegraph-Key; Oscar Kleber, of Allegheny, Pa. Application filed Aug. 28, 1889. In a telegraphic key device, the combination consisting of a tablet or suitable support to which is attached a conductor of electricity, two or more permanently parallel levers pivotally connected to the conductor, a fixed temporary contact-pin opposite each lever, a secondary conductor of electricity permanently connecting the pins, a suitable rock-bar, whereby the respective levers are alternately locked and released, a screw in each lever for regulating its stroke, and a separate spring to each lever, together with a screw for adjusting the tension of the spring.

426,989. Apparatus for Electrical Communication; James L. Cutler, of Piketon, Ohio. Application filed February 8, 1890. In an electrical apparatus for controlling one or more local circuits the combination, with a main line, of a mechanical advanced and an electrically released carriage or support having a double series of conducting and non-conducting pins, points, or projections arranged in accordance with a predetermined series of intelligible signals, a contact pawl adapted to vibrate from one series to the other and free to swing in a direction opposite to the normal movement of the carriage, a circuit normally connected with the line and controlling the vibrations of the pawl, and a restoring circuit operated by a local battery which it switches in by the engagement of the contact pawl with one of the conducting pins on the carriage.

426,992. Electrical Measuring Instrument; Madison M. Garver, of Newark, N. J. Application filed Jan. 18, 1890. In combination with the branches of a divided conductor in an electrical circuit, a body capable of conducting heat interposed between the branches and situated near enough to both to receive and emit heat radiation from and to each other.

427,014. Electrical Tell-Tale Device; Edward F. Roberts, of Rochester, N. Y. Application filed June 11, 1889. The combination of a conducting bridge piece attached to the index finger of a meter, alternating conducting and non-conducting segments which surround the arbor of the index finger and on which the bridge piece bears, an electrical circuit, to one terminal of which half of the conducting segments are connected, while the other half are connected to the other terminal, an electro-magnet in the circuit, an armature for the magnet, and a tell-tale device operated by the vibrations of the armature.

427,022. Electrical Measuring Instrument; Edward Weston, of Newark, N. J. Application filed Jan. 18, 1890. A means of producing a field force, a body movable in the field under the influence of an electric current, and a body of non-inductive resilient material also in the field and interposed between the movable body and an abutment.

427,024. Circuit Closer; Henry Burnside Whitaker, of River Point, R. I., Assignor of one-third to James A. Matteson, of same place. Application filed Feb. 1, 1890. In a circuit closer, the combination, with two stationary contact points, of an elastic metal cap placed over the contact points, a screw, and a turn button which is in connection with the screw, and is adapted to press the elastic cap in contact with the stationary points.

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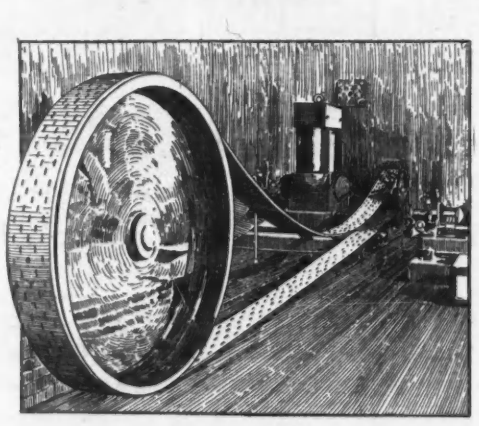

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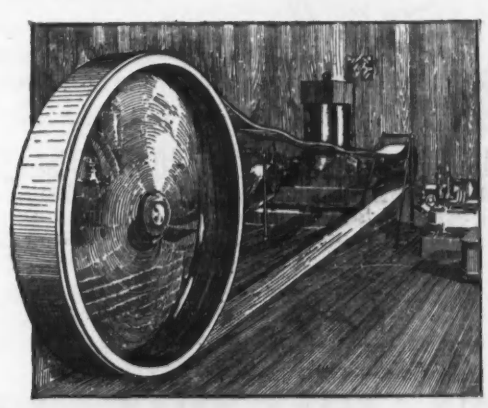

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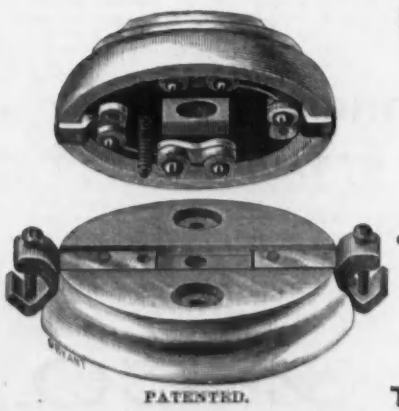

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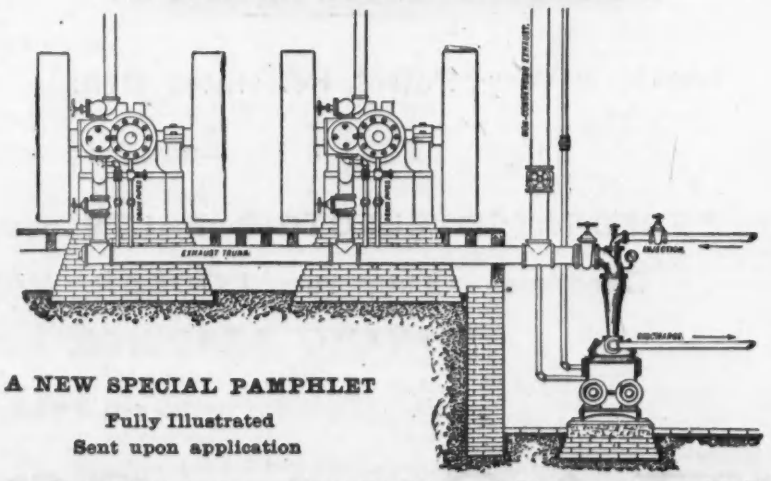

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